
System capacities

This section describes the six primary capacity categories of the Meridian 1 system: hardware, network traffic, signaling and data link, processor load, memory size, and mass storage size. For each category, the units in which the capacity is measured are identified. Primary physical and functional elements affecting the capacity are detailed, and actions which can be used to engineer the capacity are described. An algorithm is given by which capacity impacts can be computed.

The worksheets in [“Worksheets” on page 231](#) implement the algorithms. In some cases applications such as call center require detailed engineering. These applications are discussed in [“Application engineering” on page 135](#).

Hardware

The hardware resources considered in this section include physical capacity, power, and heat dissipation. Here, physical capacity is a broad term that is used to subsume three specific resources: loops, slots, and I/O devices. An overview of the physical configuration provides an explanation for the slot constraints.

Physical configuration overview

System types

Option 11 (11E / 11C) The option 11 is a small Meridian PBX, offering the advantage of simple installation, maintenance, and administration, while retaining the full features of a large system. Option 11 uses XPE hardware to maintain compatibility with other Meridian systems.

The main difference in architecture of option 11 from larger Meridian systems is that it extends the CPU bus to XPE slots, thus eliminating the network bus, and limiting the network capacity to 320 timeslots per box. This architecture eliminates one level of bit-to-byte and byte-to-bit conversion, and also eliminates a phase lock loop circuit to synchronize the DS-30 5 MHz timing to the MSL-1 network bus 8 MHz timing.

The maximum sized option 11 consists of three boxes, a base box, the box with daughterboard, and the expansion box. The maximized option 11C has a main cabinet with two expansion cabinets.

Option 11E (not supported in X11 Release 22 or higher) The base box comprises the COMBO pack which is a direct replacement for three existing option 11 packs: CPU/CONF, TDS/DTR and XTD.

The COMBO pack consists of CPU, 128k words of Udata, 128k words of Pdata, Network Conference, 8 DTR/DTD units, and three SDI ports. The COMBO pack also supports an expansion daughterboard to add extra switching capacity (10 more DS30X loops for 10 XPE slots) and memory size (128k word Udata/Pdata) to the system.

The expansion box consists of 10 XPE slots.

A SPORT pack consists of two ESDI/SDI ports and two DCHI/SDI ports.

Any of PRI, BRA, RAN, XDLC, XUT packs, and Meridian Mail will take one XPE slot. The Meridian Mail must be installed in the tenth slot of the base box. The system with the daughterboard has a total of 20 slots. With the expansion box, it has 30 slots. The first slot is reserved for CPU and service functions. The maximum number of total traffic slots in the system is 29. The system capacity is reduced when features requiring XPE slots for interface are deployed, e.g., AML or Meridian Mail.

The daughterboard is connected to the base system by a copper cable or an optional optics package. The expansion box is connected to the base system by a single fiber cable. The expansion daughterboard contains signaling channels that are not required for the base system. Packs requiring direct access to the CPU bus, such as PRI, are supported in the base box only.

The system has a total of 960 timeslots when daughterboard and expansion box are equipped. The network is non-blocking. The 960 timeslots are split up into 30 DS30X loops, each with 32 timeslots. The system backplanes in all boxes can interface with 24 ports from each XPE slot. This assures that at least one timeslot is available to every port.

The basic building blocks in the system are the XPE hardware of the 16-port line card (XDLC) and the 8-port trunk card (XUT) or 24/30-port PRIs.

A simplified block diagram of the base box and expansion boxes is shown in [Figure 6](#) and as follows:

Legend:

COMBO: Combination of CPU/CONF and TDS/DTR packs

SPORT: Small System I/O Ports (2 ESDI/SDI and 2 DCHI/SDI)

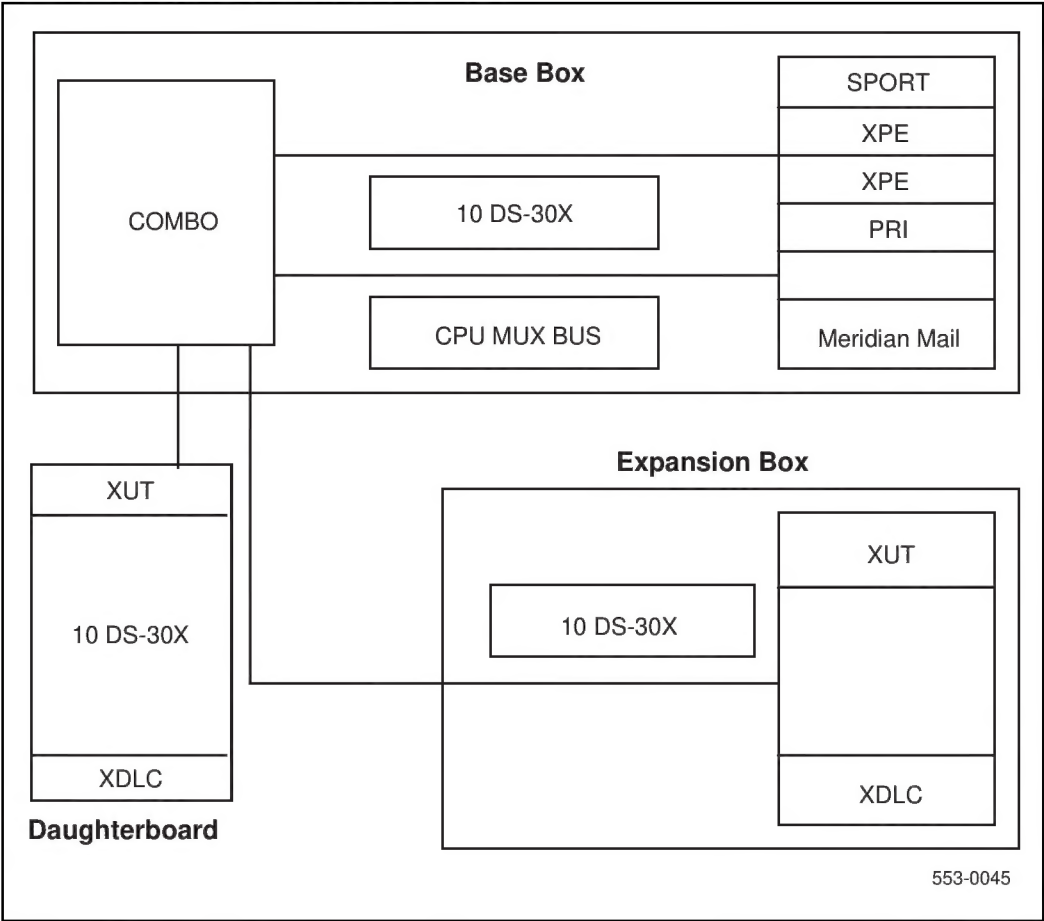
XDLC: Extended Digital Line Card

XTD: Extended DTD and DTR (dial tone detector and digitone receiver), an international pack

XUT: Extended Universal Trunk Card

XPE: Extended Peripheral Equipment, the slot can be used for XDLC or XUT

Figure 6
Simplified block diagram of the base box



Option 11C The Option 11C is an upgrade of the Option 11 to a Motorola 68040 CPU with VxWorks operating system. This affects the real time performance and the memory architecture. Its real time capacity is about 8 times that of the Option 11, but its physical capacity is still the same. (In actual practice it is greater for some configurations, now that real time is no longer a constraint.)

The memory architecture of the 11C is most like that of the Option 81 equipped with the NT9D19 call processor. Program and data are stored in physically separate memory components - flash EPROM and DRAM, respectively. DRAM is presently (Release 23) one 8 Mb SIMM in the single DRAM slot, which can be replaced with a 16Mb or 32Mb SIMM. EPROM is on a daughterboard which allows 24Mb program storage. This can be increased by adding a “babyboard” whose capacity can grow in 8Mb increments. Residing on the EPROM daughterboard is also the 8Mb of disk emulator ROM. The plan for increasing memory capacity on these systems has yet to be fully worked out.

For a detailed description of the hardware architecture of the option 11C, see the overview *Option 11C, General Information and Planning Handbook* (553-3021-200).

Option 21 (not supported in X11 Release 22 or higher) The option 21 is a single group, single CPU system with limited card slots for common equipment. In the NT8D11 CE/PE module, there are seven network card slots (slots 4 to 10). The number 10 slot is always equipped with the NT8D18 Network/DTR card, which provides DTR function and one superloop (four loops) to the IPE cards in the same module.

For practical applications, one card slot is always equipped with TDS/CON (Tone and Digit Switch/Conference) card. The remaining 5 slots can equip 5 XNET cards or 5 Enhanced Network (ENET) cards. With 6 XNET cards (including the Network/DTR card), and one TDS/CON card, the system can have a maximum of 26 loops.

Alternatively, when all 5 card slots are equipped with ENET cards plus the TDS/CON card, they support 12 loops. Adding 4 IPE loops associated with the NT8D18 Network DTR card, the system can equip a maximum of 16 loops (but with no slot for Enhanced Serial Data Interface [ESDI], D-Channel Interface [DCHI], and so on).

Option 61 (not supported in X11 Release 22 or higher) An option 61 consists of two CPU/Network modules and up to five IPE and UEM modules. The NT6D39 CPU/Network card has eight card slots for Network and I/O cards. In addition, there is a fixed slot for the Clock Controller and the serial data interface (SDI) which is not included in the eight slots. It is assumed that one TDS/CON card is equipped per CPU/Network module. Without considering applications, 14 card slots can support 28 enhanced peripheral equipment (EPE) or IPE traffic loops.

The option 61 has a maximum of 28 traffic loops (32, if TDS/CON loops are counted); it appears that as long as some IPEs are used, the system will run out of loops before it will run out of card slots.

Option 71/81 (Option 71 not supported in X11 Release 22 or higher) The option 71/81 comprises a maximum of 10 NT8D35 Network Modules when the system is fully equipped with 5 groups. Each network module has 8 slots for network cards. Therefore, a maximum of 80 slots or 160 loops is allowed in the system. As a general practice, two TDS/CON cards are assigned to each group, so the number of loops usable for general traffic becomes 28. The system capacity becomes 70 slots or 140 loops. This should be the upper limit for general applications.

Other than a potential space limitation in a switch room, the number of NT8D35 modules used for providing power and space can be as many as needed. Therefore, the capacity constraint in an option 71 or 81 is the number of loops, not card slots.

For a more detailed description of system types and modules, see *Meridian 1 system overview* (553-3001-100).

Physical capacity

Resource constraints

The physical constraints consist primarily of loop card slot limitations at the network shelf. From practical experience, running out of PE shelves is rare, particularly for Call Center applications.

Option 11 (11E/11C)

The base box in option 11 has 10 XPE slots with 9 available for general use. The expansion daughterboard provides 10 XPE slots, and the expansion box has 10 additional XPE slots. The number of available card slots is the limit of the physical capacity of an option 11.

For the purpose of card slot calculation, an agent supervisor set is treated like an agent set, however, its call intensity is reduced for real time calculations.

1 Agent Sets and Analog Trunks

When the system serves as a Call Center, it will most likely be equipped with more trunks than agent sets (lines). A practical trunk to agent ratio is within the range of 1.1 to 1.5. The reason for having a higher number of trunks is that there are calls in the queue which engage trunk circuits but not ACD agents until they are served. In addition, in an NACD application, the overflowed calls continue to occupy trunks without the service of agents at the source node.

An XDLC card can accommodate 16 agent sets, and an XUT analog card can serve 8 trunks. These numbers of ports per card and ratio are used as the basis of calculations in this document. Any other cards used which different from these numbers will change the equations. Let L = the number of lines, agent sets and supervisor sets, T = the number of trunks, N_1 = the number of XPE slots for agent sets and analog trunks. Use the following equation to calculate the number of slots required:

$$\text{Number of slots for agent sets with analog trunks} = N_1 = [L/16]^+ + [T/8]^+.$$

$[]^+$ means use the next higher integer, or “round-up”. For example, $[4]^+ = 4$ and $[3.1]^+ = 4$.

If $N_1 > 29$, the configuration requirement exceeds the capacity of an option 11.

2 Agent Sets and PRI trunks

This configuration requires that all PRI cards (NTAK09-1.5Mb) be equipped in the base cabinet from slot 1 through 9. Although Clock Controller (NTAK20) and D-channel (NTAK93) cards are needed for PRI applications, they are daughter boards used in conjunction with the PRI card and therefore, do not take up an XPE slot. We will ignore them for the purpose of calculating card slot requirements.

TDS/DTR functions are provided by the CPU card, they do not require any XPE slot. There are a maximum of 29 slots available for a combination of PRI cards and XDLC cards for agents. The split of slots for trunks and agents should meet the objective of providing a balanced trunk/agent traffic. The following equation provides the calculation procedure for digital trunks:

$$\text{Number of slots for agent sets with digital trunks} = N_2 = [L/16]^+ + [(T+2)/24]^+.$$

If $N_2 > 29$, the configuration requirement exceeds the capacity of an option 11. When a back-up D-channel is not needed, the term $(T+2)$ in the equation can be replaced by $(T+1)$.

For an international version PRI, a card has 30 ports instead of 24. Since 30B+D is always required (no nB+D), the last term in the equation should read $[T/30]$.

3 Slots for RAN, MUS, MMail and Applications

Ports in a trunk card can be configured to provide RAN or MUSic service. Except for very special applications, one XUT card is usually sufficient for this type of services. We will always assume that one XUT is adequate in the following procedure.

To provide ESDI ports for AML applications, such as CCR or HER, a SPORT card is needed. Use the following equation to calculate the number of slots required:

$$\text{Number of slots for service ports} = N_3 = 1 \text{ (for RAN/MUS)} + 1 \text{ (for Meridian Mail)} + 1 \text{ (for AML/CCR/HER)}$$

Since there are 3 SDI ports on the COMBO card (two are used for TTYs), we assume that there is no need to add a DCH/SDI card (NTAK02) for additional SDI ports for (MAX or CDR).

4 Physical Limit

The following procedure can be used to calculate N_t , the total number of card slots required in the system:

$N_t = N_1 + N_3$, if agent sets and all analog trunks.

$N_t = N_2 + N_3$, if agent sets and all digital trunks.

When a system allows a mixed analog and digital trunks, the total number of slots can be calculated as follows:

$N_t = N_1 + N_2 + N_3$, if agent sets and mixed analog and digital trunks.

If the total number of card slots (N_t) is less than or equal to 9, one base cabinet is sufficient to meet the configuration requirement.

If $29 \geq N_t > 9$, the configuration can be met by option 11 with a daughterboard and the expansion box.

If $N_t > 29$, the configuration requirement can not be met by an option 11.

Option 21, 51, 51C, 61, 61C, 71, 81, 81C

Loop constraints The maximum number of loops in a network group is 32, including service loops. For practical applications, the number of traffic loops is usually limited to 28, reserving two loops each for TDS and Conference.

1 Non-ACD (non-Automatic Call Distribution) sets and analog trunks

Non-ACD sets and trunks will be treated differently from ACD applications for estimating loop requirements. These circuits are equipped in the PE shelf, and do not use slots in the Network shelf, and, therefore, will not be included in the Network Module Card Slots Calculation.

If there is any doubt about potentially running out of PE slots for a given application (for example, Hotel/Motel environment), going over PE slots to check possible card slot limitations may be desired. Since this is a rare occurrence, a calculation procedure will not be developed for it.

For Call Center applications, due to high common channel signalling (CCS) on circuits (agents or trunks), there is no need to be concerned about physical slot constraints on the PE shelf since real time will be the limiting resource.

The following procedure should be usable for general and Call Center applications.

For EPE ENET loops:

Number of loops for non-ACD set and trunk traffic = $N_{0e} =$

$[(\text{No. of sets} \times 6 + \text{No. of non-ACD trunks} \times 26)/660]^+$

For IPE XNET loops:

Number of loops for non-ACD set and trunk traffic = $N_{0x} =$

$[(\text{No. of sets} \times 6 + \text{No. of non-ACD trunks} \times 26)/875]^+$

and $N_0 = N_{0e} + N_{0x}$

The above calculations account for blocking ENET and XNET loops.

$[]^+$ means use the next higher integer, or “round up.” For example, $[4]^+ = 4$ and $[3.1]^+ = 4$.

To simplify the notation in this document, the “+” at the upper right corner of the bracket will be omitted. Therefore, $[x]$ will mean to round up x to the next higher integer.

The default value of 6 CCS per set and 26 CCS per trunk can be replaced by actual numbers for a particular site if they are given. Note that the default trunk traffic assumed for non-ACD application is lower than that of an ACD trunk (28 CCS). The 875 CCS per loop in IPE is derived from superloop capacity of 3500 CCS divided by 4 to obtain the average CCS per loop.

When Primary Rate Interface (PRI) trunks are involved in non-ACD applications, they should be treated just like ACD PRI trunks and included in the calculations for both loop and card slot requirements.

2 Agent sets and ACD analog trunks

When the system serves as a Call Center, it will most likely be equipped with more trunks than agent sets (lines). The reason for having a higher number of trunks is that there are calls in the queue which engage trunk circuits but not ACD agents until being served. In addition, in an NACD application, the overflowed calls continue to occupy trunks without the service of agents at the source node. However, this trunk-to-agent ratio may change if a service requires a long post-call processing time from an agent. In that case, CCS per agent should be reduced reflecting the actual agent service time which are associated with actual calls to the Meridian 1 CPU.

Traffic at agent sets is conservatively assumed to be 33 CCS and 18.3 ($= 33 \times 100/180$) calls per agent in the busy hour as a default in examples. For applications with long post-call processing time, the numbers 18 CCS and 10 calls per agent perhaps are appropriate default values.

Based on the standard Meridian 1 engineering rules, a loop can handle 660 CCS and a superloop can handle 3500 CCS. When an agent is loaded to 33 CCS, a loop can equip 20 agents ($= 660/33$) and a superloop 106 ($= 3500/33$); both numbers are less than their respective number of time slots (30 for loop, 120 for superloop). Thus, normal network engineering rules for Meridian 1 do not apply in a Call Center environment, because the “infinite traffic source” assumption in the Erlang model is violated.

The traffic model will be ignored here. Instead the rule of equipping 30 agents per loop and 120 agents per superloop for a nonblocking connection will be used. A superloop was created to take advantage of the traffic theory that a bigger server group is more efficient than a smaller one. This is no longer true in a nonblocking application, so any superloop can be replaced by four loops without capacity impact. If IPE is desired, divide the required number of loops by four to get the equivalent number of superloops (except for a DTI/PRI loop which has to be an EPE loop).

For loop requirement calculations, an agent supervisor set is treated like an agent set; however, its call intensity is reduced for real time calculations.

The following is the calculation procedure for loop requirements. Let the number of agent sets be L_1 , the number of supervisor sets be L_2 , the number of ACD analog trunks be T_a , and the number of Recorded Announcement (RAN) trunks be T_r :

Number of nonblocking loops for agent sets, supervisor sets and ACD analog trunks = $N_1 = [(L_1 + L_2 + T_a + T_r)/30]$

3 DTI/PRI trunks

At an average of 28 CCS per trunk, a loop of 660 CCS can equip 23 (=660/28) trunks. It is more practical to equip 24 trunks per PRI/DTI loop as a rule rather than doing traffic calculations. Let T_d be the number of DTI trunks and T_p be the number of PRI trunks.

The equations for trunk loop calculation are as follows:

Number of loops for DTI trunks, $N_{2d} = [T_d/24]$.

Number of loops for PRI trunks, $N_{2p} = [(T_p + 2)/24]$.

Number of loops for digital trunks, $N_2 = N_{2d} + N_{2p}$.

When a back-up D-channel is not needed, the term $(T_p + 2)$ in the equation for PRI trunks can be replaced by $(T_p + 1)$.

When the number of analog trunks is small (say, 15 or less), it may be included in the N_0 calculation to save loop and slot requirements.

Techniques for reducing the number of card slots required will be illustrated in engineering examples with small systems where physical slots are scarce.

For the international version of PRI, 24 ports should be replaced by 30 in the above calculations. The rest of the engineering procedure is the same.

4 Loops for Music (MUS) and Meridian Mail (MM) applications

Music in the Meridian 1 is provided by broadcasting a music source to a conference loop. Therefore, a maximum of 30 users can listen to music at one time, which is sufficient for most applications. If not, an additional conference loop must be provided for each additional 30 simultaneous music users.

Meridian Mail ports are interfaced with a loop to provide voice channels for messaging. Each set of 24 ports in the MM is interfaced with one loop. The conference loop connects to one half of the TDS/CON card. The second conference loop, if needed, will take another card and card slot, because it cannot be separated from the TDS loop.

The network to interface MM must be an ENET. The MM Module takes up a whole shelf, normally underneath the CE/PE or CPU module. Therefore, it does not impact the available card slots in the Network Module (other than requiring an ENET loop for providing voice channels).

Calculation procedure:

$$N_{31} = [\text{Music ports}/30]$$

$$N_{32} = [\text{MM ports for MM or MIVR or HEVP}/24]$$

$$\text{Number of loops for applications, } N_3 = N_{31} + N_{32}$$

5 Physical limits in loops

The following procedure can be used to calculate N_L , the total number of network loops required in the system:

$$N_L = N_1 + N_2 + N_3.$$

Conference loops and TDS loops are called service loops. A service loop in EPE takes up the space of a dual network loop. The new Conference/TDS loop, combining two functions into one card, also takes up the same space.

A Music feature requires a Conference loop, a RAN card or a DTR card, each of which takes up a PE slot. In a small system, the service circuit will impact the number of card slots available for lines and trunks. The capacity impact of these service loops or circuits will be described.

Slot constraints A network loop provides the channels connecting line and trunk cards in the PE shelf to a Network Card (ENET or XNET) in the network shelf. All cards with system functions, such as ENET, XNET, TDS/CON, SDI, ESDI, Multi-purpose Serial Data Interface (MSDL), Multi-purpose ISDN Signaling Processor (MISP), Clock Controller, are required to be equipped in the network shelf.

With only seven card slots in the NT8D11 CE/PE module for option 21/21E, eight card slots in the NT6D39 CPU/Network module for option 61, and eight card slots in the NT5D21 Core/Network Module for Option 61C, the availability of card slots in the network shelf tends to be the bottleneck for Call Center applications on small systems.

To relieve the slot shortage on the network shelf, a NT8D35 Network Module can be used in place of a UEM module (generalized term for any of IPE/PE/RPE/Network modules) for options 21/21E and 61. This module provides space and power for QPC720 PRI/DTI cards, but it does not have loops to support the QPC414 network card or to provide I/O interfaces. A user who is not able to upgrade a small system to a larger one may want to consider this option to extend the system to its maximum physical size.

Another function which competes for network card slots is I/O ports for applications. I/O ports are needed for MM (Command Status Link [CSL]), Customer Controlled Routing/Host Enhanced Routing (CCR/HER) (Application Module Link [AML]), MAX (High Speed Link [HSL]) and TTY (SDI).

There is a slight difference in the demand for I/O card slots between options 21 and 61 or 61C, since the latter have slots available for I/O in the CPU shelf. Besides, if a Clock Controller in the CPU shelf is not needed in an option 61 or 61C, its card slot can also be used for an SDI card.

To avoid complication in the worksheet, these fine points are pointed out here for the user to consider; however, they will not be included as alternatives in the card slot worksheet.

Large systems like options 71 and 81, may require multiple MSDL cards; however, since there is no practical limitation to the number of network slots, only loop limitations are considered in these cases.

The physical relations of cards discussed above are summarized in [Table 4](#).

Table 4
Physical characteristics of cards and modules in Meridian 1

Name of card/module	No. of loops	Card slots	No. of ports/cards	Comments
QPC414 ENET	2	1		Required for MM ports, DTI, PRI loops
NT8D04 XNET	4	1		Adjacent slot must be an I/O card
NT8D17 TDS/CON	2	1		1 network module, not separable
NT8D18 Network/DTR	4	1		Fixed #10 slot in option 21 NT8D11 network module
QPC720 PRI/DTI		2		Required for PRI/DTI T1s
ESDI		1	2	For Mail (CSL), AML, CCR, HER
DCHI		1	1 & 1	1 DCHI port, 1 SDI port; for PRI & NACD
SDI		1	2	For MMax (HSL), CDR
MSDL/MISP		1	4	provides SDI, ESDI and DCHI functions
NT8D11 CE/PE module		7		Option 21; NT8D18 card slot included
NT6D39 CPU/Network module		8		Option 61; CC & extra SDI slot in CE
NT5D21 Core/Network module		8		Option 61C; CC & extra SDI slot in CE
NT8D35 Network module		8		Option 71, 81, 81C; extra space for options 21/61/61C

Note that MSDL cards are available only with X11 release 18 or later. In X11 release 18, MSDL supports ESDI and DCHI. With X11 release 19 and later, SDI functionality is added to the card's function.

1 General description of card slot requirements

The option 21 is a single group, single CPU system with limited card slots for common equipment. In the NT8D11 CE/PE module, there are seven network card slots (slots 4 to 10). The number 10 slot is always equipped with the NT8D18 Network/DTR card, which provides DTR function and one superloop (four loops) to the IPE cards in the same module. Note that there is no address constraint for two adjacent slots for option 21.

For practical applications, one card slot is always equipped with a TDS/CON card. The remaining 5 slots can equip 5 XNET cards or 5 ENET cards. With 6 XNET cards (including the Network/DTR card), and one TDS/CON card, the system can have a maximum of 26 loops.

Alternatively, when all 5 card slots are equipped with ENET cards plus the TDS/CON card, the system supports 12 loops. Adding 4 IPE loops associated with the NT8D18 Network DTR card, the system can equip a maximum of 16 loops (but with no slots for ESDI, DCHI, and so on).

It is not practical for an option 21/21E to provide PRI without a network module for QPC720, since the network shelf allows one loop to interface PRI trunks and one loop to connect to the PE module for agent sets, and the rest of the slots are used for QPC720, DCHI and Clock Controller cards. This leaves very few card slots in the network shelf for other applications. With DTI, there is one more slot available (no DCHI) which can provide two more loops (if an ENET card is used) or four more loops (if an XNET card is used).

An option 61 consists of two CPU/Network modules and up to five IPE and UEM modules. The NT6D39 CPU/Network module has eight card slots for Network and I/O cards. In addition, there is a fixed slot for a Clock Controller and an SDI which is not included in the eight slots. It is assumed that one TDS/CON card is equipped per CPU/Network module. Without considering applications, the 14 card slots can support 28 EPE or IPE traffic loops.

Note that since there are 8 card slots in an NT8D35 module, a maximum of 4 NT8D04 Superloop Network cards, or 16 loops, can be equipped per module without being adjacent to each other; the other 4 slots can be used for I/O cards.

The option 61 has a maximum of 32 loops, if TDS/CON loops are also counted. Note that when a system requires between 16 and 26 loops, it can be served by either an option 21 or 61. The decision can be made by card slot and real time requirements of the configuration.

It appears that as long as some IPEs are used, an option 61 will run out of loops before it will run out of card slots. For example, in a system of 14 slots, 7 NT8D04 XNET cards (slots) will use up all 28 loops while there are still 7 slots available for other functions. However, if the PRI/DTI feature is deployed, the card slots will run out very quickly.

From a slot perspective, option 61C with the NT5D21 Core/Network Module is comparable to option 61 with the NT6D39 CPU/Network Module.

The option 71/81 comprises a maximum of 10 NT8D35 Network Modules when the system is fully equipped with 5 groups. Each network module has 8 slots for network cards. Therefore, a maximum of 80 slots or 160 loops is allowed in the system. As a general practice, we assign 2 TDS/CON cards to each group, so the number of loops usable for general traffic becomes 28. The system capacity becomes 70 slots or 140 loops. This should be the upper limit for general applications.

The reason a 5-group system can interface only 10 NT8D35 Network Modules is because each group can accommodate a maximum of 32 loops by equipping 16 QPC414 ENET cards in 16 card slots of the two modules in a group.

If an NT8D35 module is used mainly for providing power and space for QPC720 PRI/DTI cards without loops, it is not counted as one of the 10 modules. Therefore, each supporting module can accommodate 6 QPC720 doubled sized cards, which are cabled to an NT8D35 module with 3 QPC414 ENET cards to provide 6 loops for T1's.

Other than potential space limitations in the switch room, the number of NT8D35 modules used for providing power and space is unlimited. Therefore, the capacity constraint in an option 71 or 81 is the number of loops, not card slots.

From a slot perspective, option 81C with the NT5D21 Core/Network Module is comparable to option 81 with the NT8D35 Network Module.

2 Card slot calculation rules

From the above considerations, the following general rules are used to develop the card slot calculation worksheet:

- A PRI or DTI card (QPC720) takes up two card slots. On one side, it interfaces with a T1 carrier; on the other, it interfaces with one of the two loops on a QPC414 network card.
- A DCHI port is required for PRI. This port can be provided by a DCHI card (with one other port for SDI) or MSDL card (with three additional ports for other functions).
- A Clock Controller (CC) card is required for PRI or DTI. It will take one of the network slots on an option 21 but not on an option 61 where the CC can be placed on the CE shelf.
- An XNET card takes one card slot, but its adjacent slot cannot be used by either ENET or TDS/CON cards, due to address limitations. The slot next to an XNET card can equip only nonnetwork cards (such as ESDI, MSDL). This rule applies only to options 61 and 71/81. Option 21 does not have this restriction, since it has a newly designed backplane with four addresses per slot
- All ENET loops can be lumped together to avoid the inaccuracy in rounding off the number of card slots to the higher integer number.

As can be observed, a PRI or DTI card is very slot expensive due to its double width and supporting circuitry requirements. There is no practical application on an option 21 that can be equipped with PRI/DTI trunks without using a space saving network module.

In general, IPE cards and superloops should be used as much as possible to maximize the utilization of card slots.

I/O device requirements Most advanced features on the Meridian 1 are controlled by auxiliary processors which communicate with the Meridian 1 CPU on routing and other instructions. Since I/O cards compete with network cards for slot space in a network shelf, they are crucial in deciding whether a given small system is able to provide all necessary ports and features. [Table 5](#) summarizes information required to calculate the number of I/O cards needed as an input to the card slot calculation worksheet described in the following section.

Table 5
I/O interface for applications

Application	Type of link/interface	Type of port	Sync or async
AML (associated set)	AML	ESDI	Sync
CCR	AML	ESDI	Sync
CDR	RS232 C	SDI	Async
Host Enhanced Routing	AML	ESDI	Sync
Host Enhanced Voice Processing	CSL & AML	ESDI	Sync
ISL	Modem	ESDI	Sync
Interactive Voice Response	CSL	ESDI	Sync
Meridian Mail	CSL	ESDI	Sync
Meridian MAX	HSL	SDI	Async
Meridian 911	AML	ESDI	sync
Property Management System Interface (PMSI)	PMSI Link	SDI	Async
NACD (PRI)	64 kB D-Channel	DCHI	Sync
TTY (OA&M)	RS232 C	SDI	Async
Note: An ESDI card has two ports; an SDI card has two ports; a DCHI card has one DCHI port and one SDI port; an MSDI card has four combination ports			

Certain other applications such as data may require interface to I/O ports. Since they are not addressed in the context of a Call Center, they will not be covered here.

By knowing the applications for a given site, the required number of I/O ports can be calculated. Depending on the type of I/O cards provided, the number of card slots, which will be used as an input to the following worksheet, can be determined.

The Meridian 1 has a maximum of 16 I/O ports for software X11 release 17 or earlier and 64 I/O ports for X11 release 18 or later, using MSDL. This constraint may need to be considered for large systems with many application features. For smaller systems, the card slot constraint is a concern, but not the maximum number of I/O addresses.

Algorithm

The rules described in this section, which are summaries of earlier sections, will be implemented in the card slot worksheet for direct application by the user.

- 1** Determine TDS/CON card requirements: one card per Network Module or 14 loops.
- 2** Determine MUSic loop card: one TDS/CON card per music loop.
- 3** Calculate ENET cards: the total ENET loops divided by 2.
- 4** Clock Controller slot: needed when digital trunks (DTI/PRI) are used for option 21. Otherwise, put in a zero in this space.
- 5** Calculate XNET card slots: sum up all XNET loops and divide by 4 to get the card slots required. For option 21, subtract 4 from the total, since the NT8D18 Network/DTR card is always provided.
- 6** I/O card slot: the number of slots next to XNET cards that are usable only for I/O cards, regardless of whether needed or not. This rule is not applicable to option 21 network module.
- 7** QPC720 DTI/PRI slots: each card takes 2 slots if they are not provided through the expanded NT8D35 network module.
- 8** The sum of the total card slots above should not exceed 7 for option 21, 16 for option 61/61C. Under normal applications with expansion network modules, the option 71/81/81C should have no physical constraints.

The algorithm described in this section will be implemented in the card slot calculation worksheet.

Power consumption

The power consumption of intelligent peripheral equipment (IPE) and peripheral equipment (PE) circuit cards is given in [Tables 6](#) and [7](#).

The traffic assumptions used are 25 percent active (9 CCS) for digital and analog lines, and 75 percent active (30 CCS) for trunks. These values take the average efficiency of the module power supplies into account.

The power consumption of digital line cards does not vary greatly with traffic, as it may with analog line cards.

Table 6
Power consumption—IPE cards

Circuit card	Typical power (watts)
NT8D01AC Controller card-4	32
NT8D01AD Controller card-2	32
NT8D02 Digital Line card	24
NT8D03 Analog Line card	20
NT8D09 Analog Message Waiting Line card	20
NT8D14 Universal Trunk card	36
NT8D15 E&M Trunk card	34
NT8D16 Digitone Receiver card	7

Table 7
Power consumption—PE cards

Circuit card	Typical power (watts)
QPC71 E&M/DX Signaling and Paging Trunk card	2.5
QPC192 Off-Premises Extension Line card	12
QPC250 Release Line Trunk card	2.5
QPC297 Attendant Console Monitor card	7.1
QPC422 Tone Detector card	10.9
QPC430 Asynchronous Interface Line card	14.8
QPC432 4-Port Data Line card	10.2
QPC449 Loop Signaling Trunk card	15.6
QPC450 CO/FX/WATS Trunk card	7
QPC578 Integrated Services Digital Line card	24.6
QPC594 16-Port 500/2500 Line card	32.8
QPC659 Dual Loop Peripheral Buffer card	40.4
QPC723 RS-232 4-Port Interface Line card	14.8
QPC789 16-Port 500/2500 (Message Waiting) Line card	26.4

[Table 8](#) shows power consumption data for each fully configured module. This data can be used for rectifier and reserve power (battery) provisioning.

Table 8
Meridian 1 module power consumption

Module	Power consumption (watts)
NT6D39 CPU/Network Module	360
NT6D44 Meridian Mail Module	240
NT8D11 CE/PE Module	500
NT8D13 PE Module	240
NT8D34 CPU Module	260
NT8D35 Network Module	240
NT8D36 InterGroup Module	0
NT8D37 IPE Module	460
NT8D47 RPE Module	
— local site	175
— remote site	100
Pedestal (with blower unit)	50

Power calculation algorithm The method for calculating Meridian 1 system power is based on the number of modules and columns in the system, regardless of how many cards are initially equipped. This method ensures that the external power supply provides adequate capacity, under all conditions and all possible growth scenarios, for the modules installed.

Heat dissipation

Option 11 does not have a cooling system. Extensive use of circuits on an analog card could cause system temperature to rise. Using digital cards for agent sets is recommended.

The other Meridian 1 systems considered here are equipped with cooling systems and do not have heat dissipation problems under normal applications.

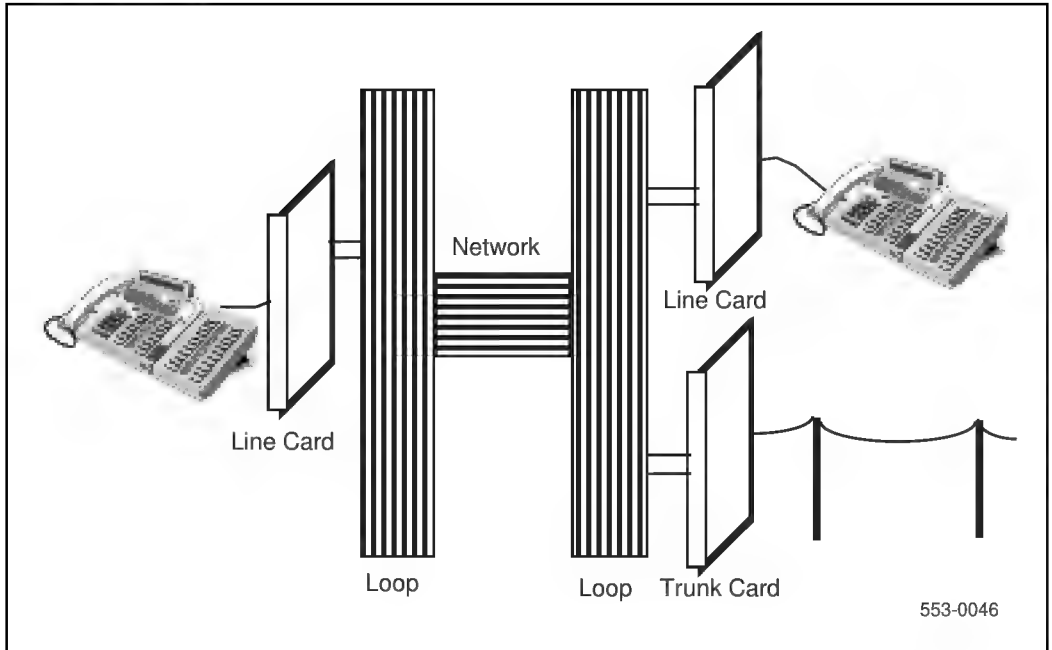
Network traffic

Traffic is a measure of the time a circuit is occupied. On the Meridian 1, the circuit normally consists of a path from the set to its line card to a loop through the network to another loop, and on to another line or trunk card attached to the terminating set or trunk as illustrated in [Figure 7](#).

Basic traffic terms used in this document are:

- An ATTEMPT is any effort on the part of a traffic source to **seize** a circuit/channel/time-slot.
- A CALL is any actual engagement or seizure of a circuit or channel by two parties.
- The CALLING RATE is the number of calls per line per busy hour: Calls/Line.
- The BUSY HOUR is the continuous 60 minute period of day having the highest traffic usage; it usually begins on the hour or half-hour.
- The HOLDING TIME is the length of time during which a call engages a traffic path or channel.
- The TRAFFIC is the total occupied time of circuits or channels, generally expressed in CCS or Erlangs: CCS—a circuit occupied 100 seconds; Erlang—a circuit occupied one hour.
- BLOCKING—Attempts not accepted by the system due to unavailability of the resource.

Figure 7
Network traffic



- OFFERED traffic = CARRIED traffic + BLOCKED traffic.
 - Traffic load in CCS = No. of calls x AHT/100.
 - Network CCS = Total CCS handled by the switching network
- or
- = CCS offered to the network by stations, trunks, attendants, Digitone receivers, conference circuits, and special features.

A loop is the physical channel that connects a network to the Peripheral Equipment (PE). Each loop is designed with a fixed number of time slots (30 for EPE loops, 120 for IPE, or Superloops). A time slot is a logical one-way channel over which voice or data information is passed during a conversation. Therefore, two timeslots are used for each normal two-way conversation. The load of information, both voice and data, which are transmitted over these time slots is called "traffic." Network traffic capacity is determined by the total number of time slots available.

Given the number of lines and trunks required in the configuration and their usage levels, the desired system network size (i.e., the number of loops/superloops needed by the system) can be determined.

Loops

The number of loops needed in the system can be calculated from lines, trunks and traffic requirements such as average holding time (AHT) and CCS. The algorithms for these computations are described in this section, and incorporated into the traffic worksheet in [“Network loop traffic capacity worksheet” on page 232.](#)

Option 11 has a non-blocking network. Each card slot is interfaced with a DS30X loop which provides 30 channels. CCS per line, trunk or agent is to be used to balance traffic among applications. There is no need to calculate CCS per loop.

Enhanced peripheral equipment (EPE)

With EPE, the loop is an Enhanced Network (ENET) loop, which has 30 time slots for general traffic. For an EPE loop, the recommended traffic is 660 CCS per loop, which meets all grade of service (GOS) requirements for network blocking. For a nonblocking application, a loop can be equipped up to 30 lines or trunks, and each circuit can carry up to 36 CCS. Two such loops are supported by each QPC414 Network card.

In addition to supporting standard peripherals (lines and trunks), an ENET loop may be used for any of the following functions:

- T1 span (DTI or PRI)
- Tone and Digit Switch (TDS)
- Conference Circuit
- Music Circuit
- Meridian Mail ports

Except for TDS and Conference, which have a special IPE card, these functions are not supported by IPE.

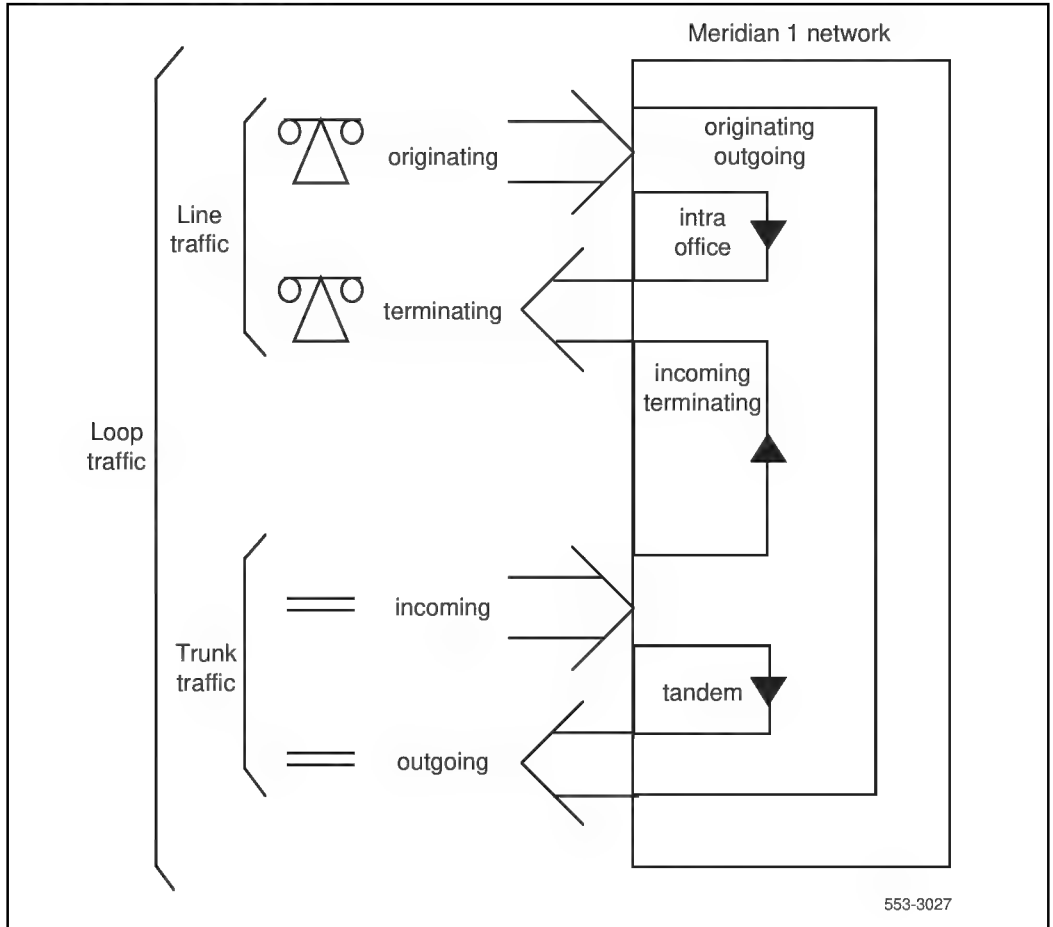
Intelligent peripheral equipment (IPE)

By combining four network loops, the superloop network card (NT8D04) makes 120 timeslots available to IPE peripheral cards. Compared to regular network loops, the increased bandwidth and larger pool of timeslots increase network traffic capacity for each 120-timeslot bundle by 25 percent (at a P.01 grade of service). The recommended traffic capacity for an IPE superloop is 3500 CCS, which meets all GOS requirements for network blocking. For nonblocking applications, a superloop can be equipped up to 120 lines or trunks, and each circuit can carry up to 36 CCS.

Lines and trunks

Line and trunk card assignment will not be discussed in this document. Detailed information is available in *Meridian 1 system engineering* (553-3001-151). This document will present the relationship between lines and trunks for the purpose of calculating loop requirements. The traffic parcels on a loop can be broken up as shown in [Figure 8](#).

Figure 8
Traffic parcels on a loop



The following variables, equations and notation (in parentheses) are used to determine the provisioning requirements of a Meridian 1 system.

- Intra-office CCS (SS)—CCS generated by station-to-station calls
- Tandem CCS (TT)—CCS generated by trunk-to-trunk calls
- Originating-outgoing CCS (ST)—CCS generated by station to trunk calls
- Terminating-incoming CCS (TS)—CCS generated by trunk to station calls
- Line CCS (L) = $2 * SS + ST + TS$
- Trunk CCS (T) = $2 * TT + ST + TS$
- Total CCS (TCCS) = $L + T$
- Intra-office ratio (R1)—the portion of the total number of calls which are station to station calls
- Tandem ratio (Rt)—the portion of the total number of calls which are trunk to trunk calls
- Incoming ratio (I)—the portion of the total number of calls which are trunk to station calls
- Outgoing ratio (O)—the portion of the total number of calls which are station to trunk calls
- Average holding time (AHT **)—average holding time for different call types (AHTss, AHTtt, AHTst, AHTts)
- Weighted average holding time (WAHT) = $(R1 * AHTss) + (Rt * AHTtt) + (I * AHTts) + (O * AHTst)$
- Total calls (Calls) = $TCCS * 100 / (2 * WAHT)$
- Intra-office calls (Css) = $R1 * Calls$
- Tandem calls (Ctt) = $Rt * Calls$
- Originating-outgoing calls (Cst) = $O * Calls$
- Terminating-incoming calls (Cts) = $I * Calls$

Poisson P.01 Table

To use the loop requirement calculation worksheet, the number of lines and trunks are given as inputs. In order to arrive at the number of trunks needed to meet the necessary GOS, the Poisson P.01 table is typically used. This table can also be used for other circuits requiring P.01 GOS, for example, RAN trunks. Refer to *Meridian 1 system engineering* (553-3001-151) for P.001 GOS and other tables.

The Poisson P.01 table is included here for easy reference.

Table 9
Trunk traffic—Poisson 1 percent blocking (Part 1 of 2)

Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS
1	0.4	31	703	61	1595	91	2530	121	3488
2	5.4	32	732	62	1626	92	2563	122	3520
3	15.7	33	760	63	1657	93	2594	123	3552
4	29.6	34	789	64	1687	94	2625	124	3594
5	46.1	35	818	65	1718	95	2657	125	3616
6	64	36	847	66	1749	96	2689	126	3648
7	84	37	876	67	1780	97	2721	127	3681
8	105	38	905	68	1811	98	2752	128	3713
9	126	39	935	69	1842	99	2784	129	3746
10	149	40	964	70	1873	100	2816	130	3778
11	172	41	993	71	1904	101	2847	131	3810
12	195	42	1023	72	1935	102	2879	132	3843
13	220	43	1052	73	1966	103	2910	133	3875
14	244	44	1082	74	1997	104	2942	134	3907
15	269	45	1112	75	2028	105	2974	135	3939
16	294	46	1142	76	2059	106	3006	136	3972
17	320	47	1171	77	2091	107	3038	137	4004
18	346	48	1201	78	2122	108	3070	138	4037
19	373	49	1231	79	2153	109	3102	139	4070
20	399	50	1261	80	2184	110	3135	140	4102
Note: For trunk traffic greater than 4427 CCS, allow 29.5 CCS per trunk.									

Table 9
Trunk traffic—Poisson 1 percent blocking (Part 2 of 2)

Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS	Trunks	CCS
21	426	51	1291	81	2215	111	3166	141	4134
22	453	52	1322	82	2247	112	3198	142	4167
23	480	53	1352	83	2278	113	3230	143	4199
24	507	54	1382	84	2310	114	3262	144	4231
25	535	55	1412	85	2341	115	3294	145	4264
26	562	56	1443	86	2373	116	3326	146	4297
27	590	57	1473	87	2404	117	3359	147	4329
28	618	58	1504	88	2436	118	3391	148	4362
29	647	59	1534	89	2467	119	3424	149	4395
30	675	60	1565	90	2499	120	3456	150	4427

Note: For trunk traffic greater than 4427 CCS, allow 29.5 CCS per trunk.

Groups

A network group is comprised of two network modules of 16 loops each for a total of 32. The maximum size of a Meridian 1 is five groups implying 160 loops. There are two types of loops: terminal loops to provide channels for general traffic, and service loops to provide tones and service functions. The number of groups in a system is determined by the number of terminal loops and service loops required, which was discussed under loop and card slot calculations.

To summarize the general rules, a group normally consists of 28 traffic loops and 2 TDS/CON dual loops for a total of 32. A multi-group system comprises multiple groups up to a maximum of five.

Once a system is larger than 32 total loops, a second group is required. To communicate between the two network groups, intergroup junctors are used.

Junctors The intergroup junctor is required once the system grows to be two groups or more. A junctor serves as a time slot extension from the originating loop of the originating group to the terminating group. The time slots on the originating loop and originating junctor need to be matched. There are eight one-way junctors from one group to every other group.

Topologically, there is a potential concentration of 32 loops from a group to 8 junctors in an intergroup junctor. With 30 traffic time slots on each junctor, 240 simultaneous two-way communications between any two groups are possible.

The junctor size is fixed and not engineerable. For special applications with high intergroup traffic, the above capacity limitation needs to be considered. The normal allowed traffic level per junctor is 660 CCS.

When lines and trunks are installed, the Community Of Interest (COI) among them should be considered, if known. Ports that have high COI should be put in the same network group to minimize intergroup junctor traffic.

Service loops and circuits

Service circuits are required in call processing to provide specific functions to satisfy the requirements of a given application. They are system resources. Service circuits also consume system resources, such as physical space, real time, memory and so on. This section will describe the traffic characteristics of service circuits, their calculation algorithms and their impact on other system resources.

TDS

The Tone and Digit Switch (TDS) loop in Meridian 1 provides dial tone, busy tone, overflow tone, ringing tone, audible ringback tone, DP or dual tone multifrequency (DTMF) outpulsing and miscellaneous tones. All these tones are provided through the maximum 30 time slots in the TDS loop.

In other words, the maximum number of simultaneous users of tone circuits is 30, whether it be 30 of one tone or a combination of many different types of tones. One TDS loop is normally recommended for each Network Module or half network group of 14 traffic loops. Additional TDS loops may be added if needed, but this is rare.

Conference

The CONference loop is a part of the dual loop NT8D17 TDS/CON card. It provides circuits for 3-way or 6-way conferences. It can also broadcast music from a source to a maximum of 30 users simultaneously. In addition, a CON loop also provides temporary hold for a variety of features, chief among them, the End to End Signaling. One CON loop is normally recommended for each half network group or 14 traffic loops.

Option 11 TDS and Conference

Option 11 has two 16-channel conference loops, eight DTR/DTD channels and 30 tone generation channels (TDS) in the COMBO pack. In addition, when the daughterboard is equipped, another 16-channel conference loop is provided.

Music MUSIC is provided through conferencing a caller to a MUS source. Therefore, a CON loop is required for the Music on Hold feature. Each set of 30 simultaneous music users will require a CON loop, thus a TDS/CON card, since these two service loops are not separable. For a small system, music users can share a conference loop with other applications. However, this is not a common practice in Call Center applications.

The MUS traffic can be calculated by the following formula:

$$\text{MUS CCS} = \# \text{ of ACD calls using MUS} \times \text{MUS HT}/100$$

A segment of music typically runs from 40 seconds to 60 seconds. If the average for a specific application is not known, a default of 60 seconds can be used. After CCS is obtained, the MUS port requirement can be estimated from a Poisson P.01 table or a delay table (such as DTR table) matching the holding time of a MUS segment.

RAN Recorded Announcement (RAN) trunks are located on 8-port trunk cards on PE shelves just like regular trunk circuits. They provide voice messages to waiting calls. RAN trunks are also needed to provide music to conference loops for music on hold.

Each RAN trunk is connected to one ACD call at a time, for the duration of the RAN message. Different RAN sources require different RAN trunk routes. If the first RAN is different from the second RAN, they need different RAN trunk routes. However, if the same message is to be used, the first RAN and second RAN can use the same route.

RAN traffic can be calculated by the following formula:

$$\text{RAN CCS} = \# \text{ of ACD calls using RAN} \times \text{RAN HT}/100$$

A RAN message typically runs from 20 seconds to 40 seconds. If the average for a specific application is not known, a default of 30 seconds can be used. After RAN CCS is obtained, RAN trunk requirements can be estimated from a Poisson P.01 table or a delay table (such as DTR table) matching the holding time of a RAN message.

DTR A Digitone receiver (DTR) serves features involving 2500 sets or Digitone trunks. DTRs are system wide resources, and should be distributed evenly over all network loops.

There are a number of features that require DTRs. General assumptions for DTR traffic calculations are as follows:

- Digitone receiver traffic is inflated by 30 percent to cover unsuccessful dialing attempts.
- Call holding times used in intra-office and outgoing call calculations is 135 seconds if actual values are unknown.
- Digitone receiver holding times are 6.2 and 14.1 seconds for intra and outgoing calls respectively.
- The number of incoming calls and outgoing calls are assumed to be equal if actual values are not specified.

The major DTR traffic sources and their calculation procedures are as follows:

1 Calculate intra-office Digitone traffic

$$\begin{aligned} \text{Intra-office} = \\ 100 \times \text{Digitone station traffic (CCS)} \div \text{AHT} \times (\text{R} \div 2) \end{aligned}$$

Recall that R is the intra-office ratio.

2 Calculate outgoing DTR traffic

$$\begin{aligned} \text{Outgoing} = \\ 100 \times \text{Digitone station traffic (CCS)} \div \text{AHT} \times (1 - \text{R} \div 2) \end{aligned}$$

3 Calculate direct inward dial (DID) DTR traffic

$$\text{DID calls} = \text{DID Digitone trunk traffic (CCS)} \times 100 \div \text{AHT}$$

4 Calculate total DTR traffic

$$\text{Total} = [(1.3 \times 6.2 \times \text{intra}) + (1.3 \times 14.1 \times \text{outgoing calls}) + (2.5 \times \text{DID calls})] \div 100$$

- 5 See [Table 10](#) to determine the number of DTRs required. Note that a weighted average for holding times should be used.

Table 10
Digitone receiver load capacity—6 to 15 second holding time (Part 1 of 2)

Average holding time in seconds	6	7	8	9	10	11	12	13	14	15
Number of DTRs										
1	0	0	0	0	0	0	0	0	0	0
2	3	2	2	2	2	2	2	2	2	2
3	11	10	10	9	9	9	9	8	8	8
4	24	23	22	21	20	19	19	19	18	18
5	41	39	37	36	35	34	33	33	32	32
6	61	57	55	53	52	50	49	49	48	47
7	83	78	75	73	71	69	68	67	66	65
8	106	101	97	94	91	89	88	86	85	84
9	131	125	120	116	113	111	109	107	106	104
10	157	150	144	140	136	133	131	129	127	126
11	185	176	170	165	161	157	154	152	150	148
12	212	203	196	190	185	182	178	176	173	171
13	241	231	223	216	211	207	203	200	198	196
14	270	259	250	243	237	233	229	225	223	220
15	300	288	278	271	264	259	255	251	248	245
16	339	317	307	298	292	286	282	278	274	271
17	361	346	335	327	320	313	310	306	302	298
18	391	377	365	356	348	342	336	331	327	324
19	422	409	396	386	378	371	364	359	355	351
20	454	438	425	414	405	398	393	388	383	379
21	487	469	455	444	435	427	420	415	410	406

Table 10
Digitone receiver load capacity—6 to 15 second holding time (Part 2 of 2)

Average holding time in seconds	6	7	8	9	10	11	12	13	14	15
22	517	501	487	475	466	456	449	443	438	434
23	550	531	516	504	494	487	479	472	467	462
24	583	563	547	535	524	515	509	502	497	491
25	615	595	579	566	555	545	537	532	526	521
26	647	628	612	598	586	576	567	560	554	548
27	680	659	642	628	618	607	597	589	583	577
28	714	691	674	659	647	638	628	620	613	607
29	746	724	706	690	678	667	659	651	644	637
30	779	758	738	723	709	698	690	682	674	668
31	813	792	771	755	742	729	719	710	703	696
32	847	822	805	788	774	761	750	741	733	726
33	882	855	835	818	804	793	781	772	763	756
34	913	889	868	850	836	825	812	803	795	787
35	947	923	900	883	867	855	844	835	826	818
36	981	957	934	916	900	886	876	866	857	850
37	1016	989	967	949	933	919	909	898	889	881
38	1051	1022	1001	982	966	951	938	928	918	912
39	1083	1055	1035	1015	999	984	970	959	949	941
40	1117	1089	1066	1046	1029	1017	1002	990	981	972
Note: Load capacity is measured in CCS.										

Traffic capacity engineering algorithms

Traffic capacities of subsystems in the Meridian 1 are estimated based on statistical models which approximate the way a call is handled in that subsystem. The traffic models used in various subsystem engineering procedures are described in the following sections.

When inputs to the algorithm are lines, trunks, average holding time (AHT), and traffic load (CCS), these algorithms can be used to determine the number of loops and system size.

Alternatively, when the loop traffic capacity is known for a given configuration, the algorithms can be used to determine the traffic level allowed at the line and trunk level while meeting GOS requirements.

Traffic Models

The basic assumptions, service criteria, and applicability of the following common models will be presented. The underlying assumptions of each model are listed:

1 Erlang B Model

- Infinite sources (traffic sources to circuits ratio $> 5:1$)
- Blocked calls cleared (no queueing)
- Applicability: loop, ringing circuit blocking

2 Erlang C Model

- Infinite sources
- Blocked calls delayed
- Infinite queue
- Applicability: Dial tone delay, I/O buffers, DIGITONE, RAN trunks

3 Engset Model

- Finite sources (traffic sources to circuits ratio $< 5:1$)
- Blocked calls cleared
- Applicability: loops with high traffic and low number of sources, blocking loops for ACD and data applications.

4 Poisson Model

- Infinite sources
- Blocked calls held for a fixed length
- Applicability: incoming/outgoing trunks, DIGITONE, Call Registers, RAN trunks

5 Binomial Model

- Finite sources
- Blocked calls held
- Applicability: small circuit groups, intergroup junctor blocking

Grade of service In a broad sense, the grade of service (GOS) encompasses everything a telephone user perceives as the quality of services rendered, including (1) frequency of connection on first attempt, (2) speed of connection, (3) accuracy of connection, (4) average speed of answer by an operator, and (5) quality of transmission.

In the context of the Meridian 1 capacity engineering, the primary GOS measures are blocking probability and average delay.

Based on the EIA Subcommittee TR-41.1 Traffic Considerations for PBX Systems, the following GOS requirements must be met:

- Dial tone delay is not greater than 3 seconds for more than 1.5 percent of call originations.
- The probability of network blocking is 0.02 or less on line-to-line connections, 0.01 or less on line-to-trunk or trunk-to-line connections.
- Blocking for ringing circuits is 0.001 or less.
- Post dialing delay is less than 1.5 seconds on all calls.

Any connection in the Meridian 1 involves two loops, one originating and one terminating. In an intergroup connection of a multi-group system, it also involves an intergroup junctor which can also incur blocking. Each stage of connection is engineered to meet 0.0033 GOS. Therefore, overall network blocking in the Meridian 1 is less than 0.01, regardless of whether the call is a line or trunk call, or an intra- or intergroup call.

Signaling and data links

Serial Data Interface (SDI)

The SDI is an asynchronous port, providing input access to Meridian 1 from an OA&M terminal, and printing out maintenance messages, traffic reports, and Call Detail Recording (CDR) records to a TTY or tape module. An SDI card has two ports. A DCHI card has one DCHI port and one SDI port. An MSDL card has four ports for a combination of interfaces. SDI is available only on an MSDL card with X11 release 19.

Enhanced Serial Data Interface (ESDI)

ESDI provides the interface for a synchronous link. An ESDI card has two ports. The maximum data rate for an ESDI port is 19,200 bps. An ESDI port is primarily used for Application Module Link (AML) types of applications.

D-channel Interface (DCHI)

The DCHI card is used for ISDN PRI D-channel signaling; it provides the interface for a 64,000 bps synchronous link. A DCHI card has one DCHI port and one SDI port. Due to memory limitations on the card, both ports cannot be used for D-channel connections.

Multi-purpose Serial Data Link and Multi-purpose ISDN Signaling Processor (MSDL/MISP)

An MSDL card has four ports providing a combination of SDI, ESDI, and DCHI functions. Using MSDL cards, the number of I/O ports in the system can reach 64. If older I/O cards are used, the maximum number per system is 16. The data rate of each port of an MSDL card is dependent on the function it provides. The maximum rate is 64,000 bps for D-channel applications, but lower for other applications.

MSDL cards can be only used with X11 release 18 or later. SDI on an MSDL is supported only on X11 release 19 software.

Functional links

For each of the following functions, the type of link and resulting capacity are given.

High Speed Link (HSL)

The HSL is an asynchronous link, used for the Meridian 1 CPU to communicate with the MAX module via an SDI port. Prior to MAX 8, the HSL bandwidth was 9600. With MAX 8 and later, 19,200 baud is available.

Application Module Link (AML)

AML is a synchronous link between the Meridian 1 and an Application Module (AM) through the ESDI port. The data rate of the link can be one of the following rates: 300, 1.2kB, 2.4kB, 4.8kB, 9.6kB, or 19.2 kbps. The standard setup between the Meridian 1 and an AM is the 19.2 kbps link.

Meridian Link (ML)

The Meridian Link is the signaling link between the AM and a host where the database for an application resides. The AM serves as an intermediary between the Meridian 1 and the host which instructs the Meridian 1 to take actions for a specific application.

Other than maintenance messages for the AM itself, there is a one-to-one correspondence between the message a host sends to the AM and the message the AM interprets and sends to the Meridian 1, and vice versa.

Communications between the AM and a host is conducted via standard X.25 protocols. Therefore, the ML interface is not limited to any particular computer vendor's products.

For practical applications, the same data rate at the AML and ML is recommended.

Command Status Link (CSL)

The CSL is the version of AML specifically used for the communications between the Meridian 1 and the Meridian Mail system (MM). It has some MM specific messages. The interface is through an ESDI port. For Meridian Mail 1 through Meridian Mail 9, the CSL link rate was 4800 baud. Beginning with Meridian Mail 10, the link rate is 9600 baud.

ISDN-AP link

The ISDN-AP link is an early version of the AML which allows direct access by DEC™ machines. Since the ML was developed, all host connections have to go through an AM. The AP link is no longer offered as an independent product, but it can be a feature in the AML called “AP Pass-through.”

OA&M

The Meridian 1 uses an SDI port to connect to a teletype (TTY) to receive maintenance commands or to print traffic reports, maintenance messages or CDR records. CDR records can also be output directly to a magnetic tape system.

ISDN Signaling Link (ISL)

An ISL provides common channel signaling for an ISDN application without PRI trunks. An analog trunk with modems at the originating switch and the terminating switch can be used as an ISL to transmit ISDN messages between these two remote Meridian 1s.

The interface for an ISL is an ESDI port. The maximum data rate for the link is 19.2 kbps.

D-channel

A PRI interface consists of 23 B-channels and one D-channel. The D-channel at 64 kbps rate is used for signaling. A D-channel interfaces with the Meridian 1 through a DCHI card or a DCHI port on an MSDL.

A D-channel on a BRI set is a 16 kbps link which is multiplexed to make a 64 kbps channel.

Property Management System Interface (PMSI)

The PMSI allows the Meridian 1 to interface directly to a customer-provided PMS through an SDI port. It is primarily used in Hotel/Motel environments to allow updates of the room status database either from the check-in counter or a guest room. The enhanced PMSI allows re-transmission of output messages from the Meridian 1 to a PMS. The maximum baud rate for this asynchronous port is 9600.

[Table 11](#) summarizes the above functional links and interfaces and provides information required to calculate the number of I/O cards needed as an input to the card slot calculation worksheet described later.

Table 11
I/O interface for applications

Application	Type of link/interface	Type of port	Sync or async
AML (associated set)	AML	ESDI	Sync
CCR	AML	ESDI	Sync
CDR	RS232 C	SDI	Async
HER	AML	ESDI	Sync
HEVP	CSL and AML	ESDI	Sync
ISL	Modem	ESDI	Sync
MIVR	CSL	ESDI	Sync
Meridian Mail	CSL	ESDI	Sync
Meridian MAX	HSL	SDI	Async
Meridian 9-1-1	AML	ESDI	sync
PMSI	PMSI Link	SDI	Async
NACD (PRI)	D-channel	DCHI	Sync
TTY (OA&M)	RS232 C	SDI	Async
Note: An ESDI card has two ports; an SDI card has two ports; a DCHI card has one DCHI port and one SDI port; an MSDL card has four combination ports			

Processor load

The Meridian 1 system consists of many processors, of which the Meridian 1 CPU is the primary one. Others exist in auxiliary platforms such as Meridian Mail, and the Applications Module. In this section methods are described to determine the load on the Meridian 1 CPU.

Meridian 1 CPU

If the Meridian 1 is running X11 release 18 or later software, the call capacity report in TFS004 can be used to determine Rated Call Capacity and current utilization levels. Otherwise, the idle cycle count method can be used to calculate processor load. If a new switch is being configured, equivalent basic calls must be calculated, to estimate the processor loading of a proposed configuration.

Idle cycle count method

A procedure called the “idle cycle count method” is used to determine the call capacity and average load on an existing Meridian 1 CPU. Two parameters are used in this procedure: idle cycle count, and CPU attempts (also called “call attempts”). These are the first and second fields, respectively, of the TFS004 traffic report (after the header). Refer to *Traffic measurement formats and output* (553-2001-450) for a description of this report.

Pairs of these fields, taken over a 24-hour period or longer, are plotted on a graph with idle cycle counts on the y-axis, and CPU attempts on the x-axis. The locus of points should be a well-defined straight line. If a few of the points fall below the line, they probably represent hours in which background activities, such as midnight routines, or maintenance were being done. These points should be ignored. If the remaining points do not define a clear straight line, error conditions and extraneous activities on the switch should be cleaned up, and a new set of measurements taken before proceeding.

Rated Call Capacity determination

Rated Call Capacity is the number of featured calls which a switch can handle without exceeding its advertised grade of service. The Rated Call Capacity of each installation is different, depending on software release, configuration, feature mix, and usage patterns. Rated Call Capacity can be determined from the graph constructed using the idle cycle count method.

For simplicity, the following description assumes that the graph was constructed from data taken from hourly traffic reports. If half-hourly reports were used, the procedure is still valid, but “hour” should be replaced by “half-hour” wherever it appears. Note that this means the rated capacity will be in terms of calls per half-hour. It should then be doubled, to make it comparable. Also, the number of milliseconds in a half-hour is 1,800,000 rather than 3,600,000.

The x-intercept is the point on the x-axis where it intersects the plotted line. The Rated Capacity of the switch is equal to 70 percent of this value. For example, if the line crosses the x-axis at 20,000 CPU attempts, then the rated capacity of the switch is:

$$0.7 \times 20,000 = 14,000 \text{ Calls-per-hour}$$

Call Service Time is the average number of milliseconds used up by a call. It can be computed by dividing the number of milliseconds in an hour (3,600,000) by the value at the x-intercept point. In the example above, the call service time is $3,600,000/20,000 = 180$ milliseconds. In other words, for this particular switch, running with a particular release, and using its unique set of features and packages, an average call requires 180 milliseconds of processor time.

Average load determination

The average load on the processor during a given hour is determined by dividing CPU Attempts (from the TFS004 report) by the Rated Call Capacity, and multiplying by 100 to produce a percentage. If the load during a certain hour on the switch in the above example was 10,500 CPU attempts, then the switch was $(10,500/14,000) \times 100 =$ percent loaded during that hour.

Real Time Remaining Required for Upgrade to Later Release

[Tables 12](#) and [13](#) show how to determine if a machine, in its present feature set configuration, has enough real time capacity to upgrade to a later software release. The determining quantity is the “percent CPU utilization”, which is obtained from the TFS004 traffic report. Use the tables to translate the percent CPU utilization on the “from” switch to the percent CPU utilization on the “to” switch by multiplying it times 1 + a percent that is within the range shown in the table cell that is located at row “from” present release and column “to” destination release. For example, a Release 19 system using 50% CPU would be using $50\% * (1+.54) = 77\%$ on Release 22. The “.54” is in the middle of the range from 42-65% shown in the 19 row, 22 column.

Table 12**Real Time Remaining Required for Upgrade (North American stream)**

	18	19	20B	21B	22	23
17	4-6%	8-12%	27-39%	37-56%	53-86%	59-103%
18		4-6%	23-31%	33-47%	49-75%	55-91%
19			18-24%	27-39%	42-65%	48-80%
20B				8-12%	21-33%	26-45%
21B					12-19%	16-30%
22						4-9%

Table 13
Real Time Remaining Required for Upgrade (International stream)

	8B	20B	21B	22	23
7C	20-23%	26-32%	36-48%	52-76%	58-92%
8B		5-7%	13-20%	27-43%	32-56%
20B			8-12%	21-33%	26-45%
21B				12-19%	16-30%
22					4-9%

Equivalent basic calls

Real time capacity of a switch can also be specified in terms of Equivalent Basic Calls (EBC). An EBC is a measure of the real time required to process a Basic Call, which is defined as follows:

Basic Call: A simple, unfeatured call between two 2500 sets on the same switch using a 4-digit dialing plan. Both sets are on EPE loops. The terminating set is allowed to ring three times, then is answered, waits approximately 2 seconds, and hangs up. The originating set then hangs up as well.

When the capacity of a switch is stated in EBC, it is independent of such variables as configuration, feature mix, and usage patterns. It still varies from release to release, and between processors. However, since it is independent of other factors, it is a good way to compare the relative call processing capability of different machines running the same software release. [Table 14](#) gives the real time capacity of the various system options for all releases since release 17.

Table 14
Real time capacity (EBC) by release and system option (EPE equipment)

System option	X11 release						
	17	18	19	20	21	22	23
Option 11E	N/A	N/A	N/A	5,800*	5,800	N/A	N/A
ST, option 21	6,600	N/A	N/A	N/A	N/A	N/A	N/A
STE, option 21E	N/A	31,100	30,350	24,700	22,450	N/A	N/A
RT, NT, XT, option 51, 61, 71	33,000	38,775	37,600	29,650	26,950	N/A	N/A
Option 11C	N/A	N/A	N/A	N/A	N/A	50,275	48,350
Option 51C/61C/81/81C w/NT6D66 CP card	N/A	81,300	78,750	63,000	49,400	43,200	40,375
Option 51C/61C/81/81C w/NT9D19 CP card	N/A	N/A	N/A	N/A	81,500	67,150	61,600
Option 51C/61C/81/81C w/NT5D10 CP card	N/A	N/A	N/A	N/A	N/A	N/A	81,925
*Options 11E and 11C do not support EPE. The rated capacity in terms of 2500-2500- set IPE calls is 6720 calls per hour. However, to use the real-time algorithm, use the adjusted value of 5,800 calls/hour to be consistent with EPE values used for other options. For option 11C use 50,275 and 48,350 (adjusted from the true IPE values of 58,000 and 55,775)							

Feature impact

Every feature which is applied to a call increases the CPU real time consumed by that call. These impacts can be measured and added incrementally to the cost of a basic call to determine the cost of a featured call. This is the basis of the algorithm used by Meridian Configurator to determine the Rated Capacity of a proposed switch configuration. Meridian Configurator is supported in US, UK, Canada and CALA only.

The incremental impact of a feature, expressed in EBC, is called the real time factor for that feature. Real time factors are computed by measuring the incremental real time for the feature in milliseconds, and dividing by the call service time of a basic call.

Each call is modeled as a basic call plus feature increments. For example, an incoming call from a DID trunk terminating on a digital set with incoming CDR is modeled as a basic call plus a real time increment for incoming DID plus an increment for digital sets plus an increment for incoming CDR.

A second factor is required to determine the overall impact of a feature on a switch. This is the “penetration factor.” The penetration factor is simply the proportion of calls in the system which invoke the feature.

The real time impact, in EBC, of a feature on the system can now be computed as follows

$$(\text{call attempts}) \times (\text{penetration factor}) \times (\text{real time factor})$$

The sum of the impacts of all features, plus the number of Call Attempts is the Real Time Load on the system, in EBC. This number can be compared with the real time capacity in [Table 14](#) to determine whether the proposed system will handle the load. If the projected real time load is larger than the system capacity, a processor upgrade is needed.

I/O impact

There are two types of I/O interface allowed at the Meridian 1: the synchronous data link and asynchronous data link. ESDI and DCHI cards provide interface to synchronous links, and an SDI card provides interface to asynchronous links. The MISP/MSDL card can provide both.

At the I/O interface, the Meridian 1 CPU processes an interrupt from SDI port on a per character basis while processing an ESDI/DCHI interrupt on a per message (multiple characters) basis. As a result, the average real time overhead is significantly higher in processing messages from a SDI port than from an ESDI port. MSDL, however, provides a ring buffer.

Auxiliary processors

Interactions with auxiliary processors also have real time impacts on the Meridian 1 CPU depending on the number and length of messages exchanged. Several applications are described in [“Application engineering” on page 135.](#)

Real time algorithm

As described above, calculating the real time usage of a configuration requires information on the number of busy hour call attempts and the penetration factors of each feature.

Busy hour calls

If the switch is already running, the number of busy hour calls or call load can be determined from the traffic printout TFS004. The second field of this report (except for the header) contains a peg count of CPU Attempts. A period of several days (a full week, if possible) should be examined to determine the maximum number of CPU attempts experienced. This number varies with season, as well. The relevant number is the average of the highest 10 values from the busiest 4-week period of the year. An estimate will do, based on current observations, if this data is not available.

If the switch is not accessible, and call load is not known or estimated from external knowledge, it may be computed. For this purpose, assumptions about the usage characteristics of sets and trunks must be made. In particular, the average holding time and CCS per hour of each type of line and trunk must be estimated. In addition, estimates for the intra-office ratio (RI), the tandem ratio (Rt), and the incoming ratio (I) are required. It is also useful to have average holding time statistics for intra-office, outgoing/originating, incoming/terminating, tandem trunk, and data calls, denoted AHTss, AHTst, AHTts, AHTtt, and AHTdata, respectively. Default values are given in [Table 15](#).

Table 15
Default traffic parameter values

Parameter	Default value
RI	.25
Rt	.05
AHTss	60 sec
AHTst	150 sec
AHTts	180 sec
AHTtt	60 sec
AHTdata	360 sec

Telephones As the primary traffic source to the system, telephones have a unique real time impact on the system. For the major types listed below, the number of telephones of each type must be given, and the CCS and AHT must be estimated. In some cases it may be necessary to separate a single type into low usage and high usage categories. For example, a typical office environment with analog telephones may have a small call center with agents on analog telephones. A typical low usage default value is 6 CCS. A typical high usage default value is 28 CCS.

- Analog: 500, 2500, message waiting 500, message waiting 2500 telephones, and CLASS sets
- Electronic: SL-1 telephones
- Digital: M2000 series Meridian Modular Telephones, voice and/or data ports
- ISDN BRI: voice and data ports
- Mobility sets
- Consoles

Trunks Trunks can be either traffic sources which generate calls to the system or a resource which satisfies traffic demands depending on the type of trunk and application involved. Default trunk CCS in an office environment is 18 CCS. Call center applications may require the default to be as high as 28 to 33 CCS.

Voice Analog:

- CO
- DID
- WATS
- FX
- CCSA
- TIE E&M
- TIE Loop Start

Digital:

- DTI: number given in terms of links, each of which provides 24 trunks under the North American standard
- PRI: number given in terms of links, each of which provides 23B+D under the North American standard
- European varieties of PRI : VNS, DASS, DPNSS, QSIG, ETSI PRI DID

Data

- Sync/Async CPU
- Async Modem Pool
- Sync/Async Modem Pool
- Sync/Async Data
- Async Data Lines

RAN The default value for AHTran is 30 seconds.

Music The default value for AHTmusic is 60 seconds.

Calculations

- Calculate Total CCS (TCCS) as $TCCS = L + T$
- Calculate weighted average holding time (WAHT):

$$WAHT = Rl \times AHT_{ss} + Rt \times AHT_{tt} + O \times AHT_{st} + I \times AHT_{ts}$$

- Calculate total number of calls (Calls):

$$Calls = TCCS \times 100 / (2 \times WAHT)$$

- Calculate number of calls for every call type:

$$C_{ss} = Rl \times Calls$$

$$C_{tt} = Rt \times Calls$$

$$C_{st} = O \times Calls$$

$$C_{ts} = I \times Calls$$

- Calculate CCSs for every type of system traffic:

$$SS = 2 \times C_{ss} \times AHT_{ss} / 100$$

$$TT = 2 \times C_{tt} \times AHT_{tt} / 100$$

$$ST = C_{st} \times AHT_{st} / 100$$

$$TS = C_{ts} \times AHT_{ts} / 100$$

- Calculate usable line and trunk CCSs:

$$L_u = SS + ST + TS$$

$$T_u = TT + ST + TS$$

- Calculate line and trunk usage ratios:

$$L_r = L_u / L$$

$$T_r = T_u / T$$

- Calculate Line and Trunk weighted average holding time:

$$WAHT_l = (R_l \times AHT_{ss} + I \times AHT_{ts} + O \times AHT_{st}) / (1 - R_t)$$

$$WAHT_t = (R_t \times AHT_{tt} + I \times AHT_{ts} + O \times AHT_{st}) / (1 - R_l)$$

- Define SETS to be the total number of sets equipped.

Features

Procedures for calculating the penetration factor for various features are given below. Since the operation of a telephone switch is extremely complex, only features which have high utilization and/or significant real time impact are considered.

In any of the cases, if the feature is not used, the penetration factor is zero.

500/2500 calls: [Total 500/2500 set CCS x L_r x 100 / WAHT_l] / Calls

SL-1 calls: [Total SL-1 set CCS x L_r x 100 / WAHT_l] / Calls

Digital set calls: [Total digital set CCS x L_r x 100 / WAHT_l] / Calls

BRI voice calls: [Total BRI set CCS x L_r x 100 / WAHT_l] / Calls

Data calls: Total data CCS x 100 / AHT_{data}

CLASS calls: $[\text{total CLASS set CCS} * \text{Lr} * 100 / \text{WAHT1}] / \text{Calls}$

CPND calls:

Let CPND set ratio (Rcpnd) = # display sets / # total sets.

Denote the average CPND name length CPNDI

The penetration factor is given by

$(\text{Cst} + \text{Cts} + 2 * \text{Css}) * \text{Lr} * \text{Rcpnd} * \text{CPNDI} / \text{Calls}$

CDP calls: $\text{O} * \text{tie trunk CCS} * \text{Tu} / (\text{Tu} + \text{Tq}) * \text{Tr} * 100 / \text{WAHTt}$

MM (CSL) calls:

$[(\text{Lr} * \text{MM CCS} * 100 / \text{AHTmm}) * (2 * \text{SS} + \text{TS}) / (\text{SS} + \text{TS}) / 2] / \text{Calls}$

where AHTmm is the average holding time of Meridian Mail calls and

MM CCS is the total Meridian Mail CCS

MM (EES) calls:

$[(\text{Lr} * \text{MM CCS} * 100 / \text{AHTmm}) * (2 * \text{SS} + \text{TS}) / (\text{SS} + \text{TS}) / 2] / \text{Calls}$

where AHTmm is the average holding time of Meridian Mail calls and

MM CCS is the total Meridian Mail CCS

NMS (Main) calls: $(\text{Lr} * \text{NMS_Main CCS} * 100 / \text{AHTmm}) / \text{Calls}$

NMS (Remote) calls: $(\text{Lr} * \text{NMS_Remote CCS} * 100 / \text{AHTmm}) / \text{Calls}$

Auto Attendant calls: $(\text{Lr} * \text{AA CCS} * 100 / \text{AHTaa}) / \text{Calls}$

where AA CCS is the total Auto Attendant CCS and AHTaa is the average holding time for Auto Attendant calls

ACD (Inbound) calls: see [“Application engineering” on page 135.](#)

ACD-D/MAX calls: see [“Application engineering” on page 135.](#)

NACD overflowed calls: see [“Application engineering” on page 135.](#)

Meridian Link calls: see [“Application engineering” on page 135.](#)

MLink status messages: see [“Application engineering” on page 135.](#)

CCR/HER calls: see [“Application engineering” on page 135.](#)

IVR (no transfer): see [“Application engineering” on page 135.](#)

IVR (transfer): see [“Application engineering” on page 135.](#)

Predictive dialing calls: see [“Application engineering” on page 135.](#)

Internal CDR calls: Rl, if internal CDR is equipped

Outgoing CDR calls: O, if outgoing CDR is equipped

Incoming CDR calls: I, if incoming CDR is equipped

Tandem CDR calls: Rt, if tandem CDR is equipped

Authorization code calls:

$0.15 \times \text{CO trunk CCS} \times \text{Tu} / (\text{Tu} + \text{Tq}) \times \text{Tr} \times 100 / \text{WAHTt}$

Off-hook queueing calls: $0.05 \times (\text{O} + \text{Rt})$

Trunk calls, incoming DTN: $(\text{I} + \text{Rt}) \times (\% \text{DTN})$

Trunk calls, incoming DIP: $(1 - \% \text{DTN}) \times (\text{I} + \text{Rt})$

Trunk calls, outgoing CO:

$[\text{O} \times \text{CO trunk CCS} \times \text{Tu} / (\text{Tu} + \text{Tq}) \times \text{Tr} \times 100 / \text{WAHTt}] / \text{Calls}$

RAN messages: see [“Application engineering” on page 135.](#)

MUSic: see [“Application engineering” on page 135.](#)

BARS/NARS calls: O, if BARS or NARS is equipped

NFCR calls: $0.1 \times \text{O}$

DTI calls: $[\text{DTI CCS} \times \text{Tu} / (\text{Tu} + \text{Tq}) \times \text{Tr} \times 100 / \text{WAHTt}] / \text{Calls}$

PRI calls: $[\text{PRI CCS} \times \text{Tu} / (\text{Tu} + \text{Tq}) \times \text{Tr} \times 100 / \text{WAHTt}] / \text{Calls}$

RVQ calls: see [“Application engineering” on page 135.](#)

Superloop calls:

$[\text{Lr} \times \text{Total Superloop Line CCS} \times 100 / \text{WAHTl} + \text{Tu} / (\text{Tu} + \text{Tq}) \times \text{Tr} \times \text{Total Superloop Trunk CCS} \times 100 / \text{WAHTt}] / \text{Calls}$

Real Time usage For each feature, Real Time Term = Penetration Factor x Real Time Factor

The Real Time Multiplier (RTM) is calculated by

$$\text{RTM} = 1 + \text{Error_term} + \sum_{\text{features}} \text{Real_time_term}_f$$

The Error_term accounts for features such as call forward or transfer, conference, multiple appearance, and so on, which are not included in the list above, and is assigned the value 0.2. In some environments such as Call Center, such features are not used, so the Error_term should be given a value of 0.

For each system and software release, there is a measured Basic Call Service Time which is the real time required to process a Basic Call. The Rated Capacity in Featured Calls is given by

$$\text{Rated Call Capacity (FC)} = 2520000 / (\text{RTM} \times \text{Basic Call Service Time}).$$

Memory size

In the following discussion, “Gamma” refers to ST and option 21 CPUs. Option 21E, STE, option 51, option 61, option 71, NT, and XT contain “Omega” CPUs. The option 51C/61C/81/81C w/NT6D66 CP card employs a Motorola 68030 CPU, option 51C/61C/81/81C w/NT9D19 CP card employs a Motorola 68040 CPU, and option 51C/61C/81/81C w/ NT5D10 CP card employs a Motorola 68060 CPU. Option 11C employs a Motorola 68040 CPU.

Memory options

The following memory cards are available:

- Option 51C/61C/81/81C w/NT6D66 CP card: 48MB of memory to store SL-1 code, SL-1 UDS and PDS plus option 81/61C/51C specific code and data. The storage media are 4 MB or 16 MB Single In-line Memory Modules (SIMMs) on the CPU board which contains slots for six of these.
- Options 71/61/21: 6 MB boards (2 Mega Word) replace old 2304kB boards.

- Option 51C/61C/81/81C w/NT9D19 CP card or NT5D10 CP card: Four SIMMs of EPROM for storing code. These SIMMs must all be the same size – either 8 MB or 16 MB. Currently 8 MB SIMMs are being used. Four SIMMs of DRAM for storing data. Each of these SIMMs can be in any of the following sizes: 2 MB, 4 MB, 8 MB, 16 MB, or 32 MB.

Table 16
Memory sizes (MB)

Machine		Typical	Maximum
Option 11C	EPROM	24 MB	40 MB
	DRAM	8 MB	32 MB
Option 51C/61C/81/81C w/NT9D19 or NT5D10 CP card	EPROM	32 MB	64 MB
	DRAM	32 MB	128 MB
Option 51C/61C/81/81C w/NT6D66 CP card		48 MB	96 MB*
Option 21E/51/61/71		12 MB	12 MB ⁺
*96 MB using 16 MB SIMMs			
⁺ 12 MB is available only on option 51 and 61 with X11 release 18 or X11 release 19 software			

Memory for NT and XT machines is supplied on one 6 MB card. Older installations may still use one or more 1536 kB memory cards. The number of cards used is machine-dependant. [Table 17](#) and [Table 18](#) outline allowable combinations of memory by machine type.

Table 17
Memory card configurations (ST, STE, NT, XT, option 21, option 51, option 71)

Board type name	“64K”	“768K”	“2M”	“3M”	“4M”
Actual byte size	128 kB	2304 kB	6 MB	6 MB	12 MB
Machine	Maximum number of boards possible				
ST, STE, option 21	2	—	—	1	1
NT, option 61	—	1	1	—	1
XT, option 71	—	3	2	—	1

Table 18
Memory configuration by X11 release (ST, STE, NT, XT, option 21, option 51, option 71)

X11 release	R18		R19		R20		R21		R22/R23	
Machine	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.
ST, STE, option 21	1x 6MB	1x 6MB	1x 6MB	1x 6MB	1x 6MB	2x 6MB	2x 6MB	2x 6MB	N/A	N/A
NT, option 61	1x 6MB	1x 6MB	1x 6MB	1x 6MB	2x 6MB	2x 6MB	2x 6MB	2x 6MB	N/A	N/A
XT, option 71	1x 6MB	2x 6MB	2x 6MB	2x 6MB	2x 6MB	2x 6MB	2x 6MB	2x 6MB	N/A	N/A

Table 19
Memory card configurations (option 11C/51C/61C/81/81C)

Board type name		"2M SIMM"	"4M SIMM"	"8M SIMM"	"16M SIMM"	"32M SIMM"
Actual byte size		2 MB	4 MB	8 MB	16 MB	32 MB
Machine		Maximum number of SIMMs possible				
Option 51C/61C/81/81C w/NT6D66 CP card		—	6	6	6	—
Option 51C/61C/81/81C w/NT9D19 or NT5D10 CP card	EPROM	—	—	4	4	—
	DRAM	4	4	4	4	4
Option 11C	DRAM	—	—	1	1	1
Option 11C	EPROM daughter board	EPROM and disk emulator ROM reside on the same daughter board. Presently EPROM has 24Mb and ROM has 8Mb. More capacity can be added in 8Mb increments in the form of "baby-boards" attached to the daughterboard.				

Table 20
DRAM size as a function of Mobility supported in Release 22 and 23

Release 22	11C		NT9D19 CP card				
DRAM size (MB)	8	16	16	32			
mobility users supported	none	500	500	1500			
OS heap allowance (MB)	3.0000	6.0000	8.2500	12.2500			
Systems with NT9D19 CP cards that support this OS heap allowance			51C 61C	81C			
Release 23	11C		NT9D19 & NT5D10 CP cards				
DRAM size (MB)	8	16	16	32	32	48	48
mobility users supported	none	500	none	none	1500	none	5000
OS heap allowance (MB)	3.0625	7.1875	6.1875	7.7500	12.3125	8.3750	17.5000

Table 20
DRAM size as a function of Mobility supported in Release 22 and 23

Release 22	11C		NT9D19 CP card				
DRAM size (MB)	8	16	16	32			
mobility users supported	none	500	500	1500			
OS heap allowance (MB)	3.0000	6.0000	8.2500	12.2500			
Systems with NT9D19 CP cards that support this OS heap allowance			51C 61C	51C 61C 81C	51C 61C 81C	81C	81C
Systems equipped with NT5D10 CP cards that support this OS heap allowance			51C	51C 61C	51C 61C	81C	81C

[Table 17](#) shows how many SIMMs and of what size it is physically possible to configure. As of Release 23, SIMMs are configured on the machines in the table as follows :

- 11C DRAM : either 1 x 8MB or 2 x 8MB
- NT6D66 CP card machines (51C/61C/81/81C) : 4 x 4MB plus 2 x 16MB
- NT9D19 and NT5D10 CP card machines (51C/61C/81C) flash EPROM : 4 x 8MB
- NT9D19 and NT5D10 CP card machines (51C/61C/81C) DRAM : see [Table 20](#)

As shown in [Table 20](#), since the introduction of the mobility feature in Release 22, different DRAM sizes are supported according to the number of mobility users the site wants to configure. The additional OS heap required to support mobility's dynamic memory use is then allocated during sysload according to the amount of DRAM in the system. CP machines are all configured with 48MB of memory and they all support 1500 mobility users.

Memory Upgrade Guidelines

Upgrades to Option 11C : A customer upgrading to Release 23 on an 11C (from 11E) may do so without considering the memory requirements for his particular configuration. That is, if it fits on 11E, then it fits on 11C.

A customer upgrading from Release 22 to Release 23 on an 11C, must continue reading.

Upgrades to option 51C/61C/81/81C machines (Options 51C/61C/81/81C with NT6D66, NT9D19 and NT5D10 CP cards) and from Release 22 to 23 on an 11C :

A customer upgrading from option 21E/51/61/71 or option 51C/61C/81/81C system to Release 23 on an option 51C/61C/81/81C system (with NT6D66 or NT9D19 CP card) must consider the size of his SL-1 database, in terms of Release 23. With this knowledge he can then determine if the 48 MB on the NT6D66 CP card is adequate for his needs, or, if he is upgrading to an option 11C or an option 51C/61C/81/81C system equipped with an NT9D19 or NT5D10 CP card, which size system and how much DRAM he will need.

To make this determination, take the following steps :

- Use MEMAVAIL display in SL-1 database user interface to determine the size of the SL-1 customer database on the system being upgraded from. The "USED" field in the MEMAVAIL display, returned by the SL-1 user interface after loading any service change overlay that can add or delete data (eg., overlay 11), gives the present size (in memory) of the SL-1 customer data base in SL-1 words. (This quantity, will be referred to as "**SL1DB-words**".)
- Compare your **SL1DB-words** with the limits shown in Table 21 below to see if your memory requirement is small enough to be able to upgrade to Release 23 on the desired machine type.
- If your customer database size is too large to upgrade to the desired

machine type and/or DRAM size, it may be possible to make it fit by configuring fewer call registers. (This is done in Overlay 17 - the configuration record user interface - with the NCR prompt after you have answered "Yes" to the PARM (change system parameters) prompt. Note that a system INIT is then required to make this change become effective.) In [Table 21](#) below are shown the recommended call register counts for each machine type, and their corresponding claims on SL-1 customer database memory. Use this as a guide to try for an optimal call register count. (As shown in the table call registers use memory at a rate of 197 words per call register.)

Table 21
MEMAVAIL USED upper bounds for UPGRADE (units = SL-1 words)

Machine being upgraded TO : (columns)	Systems with NT6D66 CP card, 48MB total memory and 1500 mobility. 51C/61C/81/81C	Systems with NT9D19 and NT5D10 CP cards, 16MB DRAM and no mobility 51C 61C (NT9D19 CP card only)	Systems with NT9D19 and NT5D10 CP cards, 32MB DRAM and no mobility 51C / 61C / 81C (NT9D19 CP card only)	Systems with NT9D19 and NT5D10 CP cards, 32MB DRAM and 1500 mobility 51C / 61C 81C (NT9D19 CP card only)	Systems with NT5D10 CP cards, 48MB DRAM and no mobility 81C	Systems with NT5D10 CP cards, 48MB DRAM and 5000 mobility 81C
Release being upgraded FROM : (rows)	<i>upgrading from options 21E/51/61/71</i>					
Release 19	1,290,991	903,173	3,368,028	2,418,005	6,132,206	4,232,159
Release 20	1,565,453	1,095,186	4,084,066	2,932,069	7,435,903	5,131,910
Release 21	1,807,387	1,264,442	4,715,240	3,385,207	8,585,088	5,925,023
	<i>upgrading from options 51C/61C/81/81C systems equipped with NT6D66 and NT9D19 CP cards</i>					

Table 21
MEMAVAIL USED upper bounds for UPGRADE (units = SL-1 words)

Machine being upgraded TO : (columns)	Systems with NT6D66 CP card, 48MB total memory and 1500 mobility. 51C/61C/81/81C	Systems with NT9D19 and NT5D10 CP cards, 16MB DRAM and no mobility 51C 61C (NT9D19 CP card only)	Systems with NT9D19 and NT5D10 CP cards, 32MB DRAM and no mobility 51C / 61C / 81C (NT9D19 CP card only)	Systems with NT9D19 and NT5D10 CP cards, 32MB DRAM and 1500 mobility 51C / 61C 81C (NT9D19 CP card only)	Systems with NT5D10 CP cards, 48MB DRAM and no mobility 81C	Systems with NT5D10 CP cards, 48MB DRAM and 5000 mobility 81C
Release 19	968,243	677,380	2,526,021	1,813,504	4,599,155	3,174,119
Release 20	1,174,090	821,390	3,063,049	2,199,052	5,576,928	3,848,932
Release 21	1,355,540	948,332	3,536,430	2,538,905	6,438,816	4,443,767
Release 22	1,491,094	1,043,165	3,890,073	2,792,796	7,082,698	4,888,144
	<i>upgrading from 11C to 11C</i>					
	8 MB DRAM	16 MB DRAM				
Release 22	167,636	1,120,074				

*A 32 MB DRAM is optional with 51C and 61C systems equipped with NT9D19 and NT5D10 CP cards. 16 MB DRAM is the default. 48MB DRAM is optional on 81/81C machines with NT5D10 CP cards. 32 MB is the default.

Table 22 provides the maximum recommended call register count by machine type. A particular configuration on a given software release may be able to configure a greater number of call registers, but there is no assurance that this higher number of call registers will be supported in subsequent releases of hardware and/or software.

Table 22
Recommended Maximum Call Register Counts and Release 23 Memory Implications

Machine Type	11C & 51C with NT6D66 CP card	61C with NT6D66 CP card	81 / 81C with NT6D66 CP card	51C with NT9D19 CP card	61C with NT9D19 CP card	81C with NT9D19C P card	51C with NT5D10C P card	61C with NT5D10C P card	81C with NT5D10C P card
Recommended Call Register Count	1000	2000	5000	1500	3000	7500	2000	4000	10000
Memory Required (SL-1 words) (Release 23)	197,000	394,000	985,000	295,500	591,000	1,477,500	394,000	788,000	1,970,000
Memory Required (MB)	0.7515	1.5300	3.7575	1.1273	2.2545	5.6363	1.5300	3.0600	7.6500

In Release 23, call registers are 197 SL-1 words long. One SL-1 word is 4 bytes.

Note: Sites experiencing memory shortages during an upgrade should check that the call register counts are within the bounds set by this table.

Many sites with 51C and 61C systems equipped with NT6D66 CP cards had been running with 5000 call registers because that was documented as a recommended maximum in previous releases when the recommendations were less machine specific. (There have also been sites trying to run with a great deal more than that.) Since all systems equipped with the NT6D66 CP card have the same amount of memory, the count recommended for the larger machines (81, 81C) will also fit into memory on the smaller ones. However, when these sites then go to upgrade to a NT9D19 or NT5D10 CP card, and opt for the smallest DRAM size (16MB) supported on 51C/61C, then there is no longer sufficient memory for the 81/81C sized call register count. In order for the system to run properly or even complete sysload it is imperative that the call register counts be reduced to the recommended maximums.

Memory partitioning

Table 23
Memory partitioning for NT, XT, 61, 71 systems

Memory allocation	Function
0 to 6kB	Fast RAM
6kB to (12kB to 180kB)	Unprotected global variables
(12kB to 180kB) to 192kB	Protected Global Variables and data store
192kB to 204kB	ROM
204kB to (204kB to 12 MB)	Program store
(204kB to 12M) to 36 MB	Protected and unprotected data
36 MB to 48 MB	Input/output

Table 24**Release 23 memory map for systems equipped with NT6D66 CP cards w/ 48 MB DRAM**

Memory bucket description	HEX address of lower boundary	# 64KB pages occupied / #MB occupied
top of memory	7000000	0 / 0
OS upper address miscellany	6fd0000	3 / 0.1875
space for patches	6e30000	26 / 1.6250
space for SL-1 customer data (udata is at the top and grows down, pdata is at the bottom and grows up)	63e0000	158 / 9.8750
sl1 resident code's fixed data	6290000	20 / 1.2500
overlay code	5db0000	78 / 4.8750
sl1 resident code	4d50000	262 / 16.3750
OS dynamic heap	41a0000	187 / 11.6875
OS code's fixed data	4170000	3 / 0.1875
OS code	4040000	19 / 1.1875
OS lower address miscellany	4000000	4 / 0.2500

Table 25**Release 23 DRAM map for systems equipped with NT9D19 and NT5D10 CP cards (32MB 1500 mobility users example)**

DRAM bucket description	HEX address of lower boundary	# 64KB pages occupied / #MB occupied
top of DRAM	a000000	0 / 0
OS upper address miscellany (includes 1MB for CPU switchover operations)	9ed0000	19 / 1.1875
space for patches	9d30000	26 / 1.6250
OS reserved for the remainder of OS dynamic heap requirement	9700000	99 / 6.1875
space for SL-1 customer data (udata is at the top and grows down, pdata is at the bottom and grows up)	8800000	240 / 15.0000
sl1 resident code's fixed data	86b0000	20 / 1.2500
OS dynamic heap base portion	8080000	99 / 6.1875
OS code's fixed data	8040000	4 / 0.2500
OS lower address miscellany	8000000	4 / 0.2500

Table 26
Release 23 Flash EPROM map for systems with NT9D19 and NT5D10 CP cards

Flash EPROM bucket description	pages actually used	HEX address of lower boundary	# 64KB pages occupied / #MB occupied
top of flash EPROM	n/a	6000000	0 / 0
flash file system	9	5c00000	64 / 4.0000
overlay code (this is also resident, but is built as a separate unit)	77	5400000	128 / 8.0000
sl1 resident code	262	4300000	272 / 17.0000
OS code	18	4100000	32 / 2.0000
boot rom	16	4000000	16 / 1.0000

In [Table 24](#) and [Table 25](#), addresses and pages occupied apply to the Gate II issue of Release 23. They are highly subject to change and are only included as a means of illustration. In the flash EPROM map ([Table 26](#)) note that code buckets begin at integral MB boundaries, and not all pages in the bucket are necessarily used.

Memory engineering

Program store

Option 51/61/71 The size of program store is dependent upon the release and the number of packages included. The number and size of the packages included can vary in any given installation. Packages 0, 1, and 2 are considered non-optional. In practice, at most 94 percent of available packages are used in any given installation. In [Table 27](#), resident SL-1 program store figures include resident code size + resident code overhead + ROM + overlay area + all optional packages.

Option 11C/51C/61C/81/81C The number of packages included is fixed; that is, all packages are included. Therefore, the program store requirement is fixed, see [Table 29](#).

Table 27
Program store size (kB) for NT, XT, 61, 71 assuming all packages loaded

	X11 release								
	14	15	16	17	18	19	20	21	22 on
Resident SL-1 program store	912	1116	1200	1347	1680	2113	3686	4004	N/A
Overlay SL-1 code	N/A	1131	1173	1185	1404	1428	1792	1872	N/A

Table 28
Program store size (MB) for option 11C/51C/61C/81/81C

Category	X11 r18	X11 r19	X11 r20	X11 r21	X11 r22	X11 r23
Code:						
Resident SL-1 code	4.5625	5.5625	9.4375	10.6875	15.8750	16.3750
Overlay SL-1 code	3.3750	3.5000	4.5000	4.5000	4.7500	4.8125
Option 81/61C/51C OS	0.6250	0.6250	0.6875	0.8125	1.0000	1.0625
Code size total	8.5625	9.6875	14.6250	16.0000	21.6250	22.2500

Option 11C/51C/61C/81/81C OS Dynamic Memory and Patching Area

The Motorola processor (with VxWorks OS) based machines require special memory allocations in addition to that for code and customer data. These allocations are : an area for patching, various fixed memory allocations for OS (not all contiguous - this includes fixed variables for SL-1 and OS code, reserved areas at the very top and bottom of memory (see “Memory partitioning” on page 99.)), and a special area reserved for dynamic OS heap allocations. Since Release 22 the OS heap includes memory allocated by SL-1 features via the VxWorks OS. In previous releases, the OS heap was used exclusively by the OS.

Table 29
Patching, Overhead and OS Heap (MB) for option 51C/61C/81/81C w/ NT6D66 CP card

Category	X11 release 20	X11 release 21	X11 release 22	x11 release 23
Patching Area	1.5000	1.5000	2.1250	2.1250
Miscellaneous Fixed Overhead	*	*	1.6875	1.7500
OS Dynamic Heap	1.8125	2.0625	10.7500	11.6875
Total	3.3125	3.5625	14.5625	15.5625

*Previous to Release 22, the fixed overhead and OS dynamic heap were lumped together in a single memory use partition.

Table 30 Patching, Overhead and OS Heap (MB) for option 11C

Category	X11 release 22 (no mobility)	X11 release 22 (500 mobility)	x11 release 23 (no mobility)	x11 release 23 (500 mobility)
Patching Area	1.0000	1.0000	1.0000	1.0000
Miscellaneous Fixed Overhead	1.3103	1.3103	1.2702	1.2702
OS Dynamic Heap	3.6100	4.9476	4.2328	7.4725
Total	5.9203	7.2579	15.5625	9.7427

Table 31
Patching and OS Heap (MB) for option 51C/61C/81/81C w/
NT9D19 card and NT5D10 card

Category	X11 release 22 16MB DRAM	X11 release 22 32MB DRAM	X11 release 23 16MB DRAM	X11 release 23 32MB DRAM	X11 release 23 48MB DRAM
Patching Area	1.1250	2.1250	1.1250	2.1250	2.6250
Miscellaneous Overhead	2.6875	2.6875	2.7500	2.7500	2.7500
OS Dynamic Heap					
no mobility users	8.2500	12.2500	6.1875	7.7500	8.3750
500 mobility users			not supported	12.3125	17.5000
1500 mobility users					
5000 mobility users	not supported	not supported			

On the NT9D19 and NT5D10 processors, the size of the patching area is a function of DRAM size. OS dynamic heap size is a function of DRAM size and mobility option. (See also Table 20 “DRAM size as a function of Mobility supported in Release 22 and 23” on page 93).

Data store

The data store consists of both protected and unprotected database information. This section describes the information stored in each area and how to determine the values for input to the memory size worksheet (see [“Memory size worksheet” on page 248](#)).

Protected data store

— Telephones:

Assumptions:

- average number of features defined per 500/2500 telephone is 8
- average number of 500/2500 telephones sharing the same template is 10
- average number of key lamp strips per SL-1 telephone is 1
- average number of SL-1/Digital telephones sharing the same template is 2
- average number of non-key features per digital set is 4.

Calculations:

- For every type of set the protected data store size is calculated using basic formula: Number of items x MS per item.

The following items are included here:

- 500/2500 telephones
- SL-1 telephones
- ACD telephones
- M2006/2008/2009 telephones
- M2016/2216/2616 telephones
- M2112 telephones
- M2018 telephones
- M2317 telephones
- M3000 telephones
- Consoles
- Add-on Modules
- Templates
- Attendants

-
- DS/VMS access TNs:
(Number of Meridian Mail ports + Number of data ports only) x
MS per DS/VMS access TN
 - Office Data Administration (ODAS):
(Number of Meridian Mail ports + Number of data ports only +
Total number of sets + Number of analog trunks) x MS for ODAS
 - Customers:
Constant term + Number of customers x MS per customer
 - Directory Number (DN) translator:
Assumptions:
 - the two lowest levels in the DN tree have average rate of 8 digits
 - the rest of the DN tree has a structure which provides the lowest possible digit rate for upper levelsCalculations:
 - $5.8 \times \text{Number of DNs} + 2 \times (2 \times \text{Number of ACD DNs} +$
 $\text{Number of ACD positions} + \text{Number of DISA DNs}) + \text{MS per}$
 $\text{console} \times \text{Number of consoles} + \text{Number of dial intercom groups}$
 - Dial Intercom Group (DIG) translator:
Maximum number of DIGs + $2 \times (\text{number of DIGs} + \text{Total number of the sets within DIGs})$
 - Direct Inward System Access (DISA):
Number of DISA DNs x MS per DISA DN
 - Authorization Code:
Assumption:
 - the length of the authorization code is in the range of 4 through 7Calculations:
 - $\text{Number of customers} \times \text{MS per customer} + 1.47 \times \text{Number of authorization codes}$
-

- Speed Call:
Maximum number of Speed Call lists + Number of Speed Call lists x
(3 + 0.26 x Average number of entries per list x DN size)
- Analog trunks:
Number of analog trunks x MS per analog trunk
- Trunk Route:
Constant term + Number of trunk routes x MS per trunk route
- Network:
Number of groups x MS per group + Number of local loops x
MS per local loop + Number of remote loops x MS per remote loop
- TDS, MF sender, Conference, DTR, Tone Detector:
Number of DTRs x MS per DTR + Number of TDSs x MS per TDS
Number of MF senders x MS per MF sender +
Number of conference cards x Ms per conference card +
Number of TDETs x MS per TDET
- ISDN PRI/PRI2:
Number of D-channels x MS per D-channel + Number of PRI trunks
+ Number of ISL trunks
- ISDN DTI/DTI2/JDMI:
Number of DTI loops x MS per DTI loop + Number of DTI2 loops x
MS per DTI2 loop
- History file:
Size for history file buffer

— Basic Alternate Route Selection/Network Alternate Route Selection (BARS/NARS):

Assumptions:

- the length of any code = 3
- the typical structure of the tree for every code (in term of digit rate) is the following:

10-10-10.... - for SPN code

8 -10-10.... - for NXX/LOC code

6-2-10-8-10... - for NPA code

Calculations:

$5684 + 31.21 \times \text{number of NPA Codes} + 1.06 \times \text{Number of NXX Codes}$

$+ 1.06 \times (\text{Number of LOC Codes} + \text{Number of SPN Codes}) +$

$2 \times \text{Number of FCAS Tables}$

— ISDN Basic Rate Interface (BRI):

Number of MISP boards $\times$ MS per MISP board +

Number of DSLs $\times$ MS per DSL + Number of TSPs $\times$ MS per TSP

+ Number of BRI DNs $\times$ MS per BRI DN

— Coordinated Dialing Plan (CDP):

Constant term + $3 \times$ Number of steering codes + $8 \times$ Number of route lists

+ $3 \times$ Total number of entries in route lists

— Call Party Name Display (CPND):

Number of trunk routes + Number of consoles + Number of ACD DNs

+ Number of SL-1 DNs + Number of digital set DNs

+ Number of Names $\times$ (5 + Average length of name)

+ Number of 1-digit DIG groups $\times$ 11

+ Number of 2-digit DIG groups $\times$ 101

- Feature Group D (FGD) Automatic Number Identification (ANI) Database:

Assumptions:

- all Numbering Plan Area (NPA) codes designated for BARS/NARS are assumed to be used for ANI also
- one NPA block is assumed for every fifty NPA codes
- five NXX blocks are assumed for each NPA block
- twenty SUB blocks are assumed for each NXX block

Calculations:

- $3 \times \text{Number of NPA Codes} + 658 \times \text{Number of NPA codes}$

- Automatic Call Distribution (ACD)/Network ACD (NACD):

Number of ACD DN's x MS per ACD DN +

Number of NACD DN's x MS per NACD DN +

Number of ACD positions x MS per ACD position +

Number of ACD agents + 11 x Number of customers

- Fixed address globals:

MS for fixed address globals

Unprotected Data Store

- Telephone:

For every telephone type (except BRI telephones) the memory size is calculated as

- Number of telephones x MS per item, where MS per item depends on the set type. For example:
- Number of 2500 telephones x MS per 2500 set,
- Number of telephones with display x MS per display, and so on

— BRI telephones:

Constant term + MS per MISP x Number of MISPs

+ MS per DSL x Number of DSLs + MS per BRI line card x Number of BRI line cards,

where

MISP stands for the Multi-purpose ISDN Signaling Processor

DSL stands for the Digital Subscriber Loop

— Analog trunks:

The following types of the analog trunks are considered:

Paging trunks, RAN trunks, AUTOVON trunks, Add-on Data Module (ADM), RLA trunks, other analog trunks.

Calculations:

- Number of paging trunks x MS per paging trunk
- Number of other analog trunks x MS per other analog trunk, and so on
- (Number of other analog trunks = Total number of analog trunks – Number of paging trunks – Number of RAN trunks – Number of AUTOVON trunks – Number of ADMs – Number of RLAs)

— Trunks (Call Detail Recording [CDR]):

Total number of trunks x MS per trunk

— BRI trunks:

Number of BRI trunks x MS per BRI trunk

— Trunk routes:

Number of trunk routes x MS per trunk route + Total number of trunks / 16.

Note: The result of division should be rounded up.

— DTI/DTI2/JDMI:

- Number of DTI loops x MS per DTI loop
- Number of DTI2 loops x MS per DTI2 loop

— ISDN PRI/PRI2/ISL

PRI:

- Number of D-channels x MS per PRI D-channel + Number of outputs
- Request buffers x MS per output request buffer +
- 2 x (Number of PRI trunks + Number of ISL trunks)

PRI2:

- Number of D-channels x MS per PRI2 D-channel + Number of output
- Request buffers x MS per output request buffer +
- 2 x (Number of PRI trunks + Number of ISL trunks)

— Teletypes:

Total number of teletypes x MS per teletype

Number of CDR links x MS per CDR link

Number of HS links x MS per HS link

Number of APL links x MS per APL link

Number of PMS links x MS per PMS link

Number of Other links x MS per other link

- For the following items (features) memory size is calculated using the basic formula

$$\text{Number of items} \times \text{MS per item}$$

where item is one of the following:

local loops, remote loops, secondary tapes, customer, Tone and Digit Switch, MF sender, Conference card, Digitone receiver, Tone Detector, attendant, Peripheral Signaling card, LPIB, HPIB, background terminal, MSDL card

Note: The size of High Priority Input Buffer = Number of Groups x 32.

- PBXOB and BCSOB:

$$\text{Number of Peripheral Signaling Cards} \times 640$$

$$\text{Number of Peripheral Signaling Cards} \times 640$$

- DS/VMS access TNs:

$$\text{MS per DS/VMS TN} \times (\text{Number of Meridian Mail Ports} + \text{Number of data only ports})$$

- Application Module Link (AML):

$$\text{Constant term} + \text{Number of AMLs} \times \text{MS per AML}$$

- Automatic Call Distribution (ACD):

If ACD-C package is not equipped, then memory size for ACD feature is

$$\text{Number of ACD DNs} \times 298 + \text{Number of ACD positions} \times 34.$$

If ACD-C package is equipped, then additional memory size for ACD-C feature is

$$\begin{aligned} &\text{Number of ACD-C routes} \times 46 + \text{Number of ACD-C positions} \times 42 + \\ &\text{Number of ACD-C DN's} + \text{Number of control directory numbers} \times \\ &80 + \text{Number of ACD-C trunks} + \text{Number of ACD-C CRTs} \times 30 + \\ &\text{Number of customers with ACD-C package} \times 240. \end{aligned}$$

— NARS/BARS/Coordinated Dialing Plan (CDP):

Assumption:

- if NTRF package is equipped, then Off Hook Queuing (OHQ) is also equipped

Calculations:

- $\text{MS per customer} \times \text{Number of customers} + 2 \times (\text{Number of route lists} \times \text{MS per route list} + \text{Number of routes with OHQ} \times \text{MS per route} + \text{Number of NCOS defined} \times \text{MS per NCOS})$

— Call registers:

Assumptions:

- The Call Register Traffic Factor = 1.865;
- The formula for the calculation of recommended Number of Call Registers depends on traffic load for the system;
- 28 CCS per ACD trunk.

Calculations:

- $\text{Call Registers Memory Size} = \text{Recommended number of call registers} \times \text{MS per call register}$
- $\text{Snacd} = \text{Number of Calls Overflowed to all target ACD DN}s \times 2.25 - \text{Number of calls overflowed to local target ACD DN}s \times 1.8$ (0, if the system is not a source node)
- $\text{Tnacd} = 0.2 \times \text{Number of expected calls overflowed from source}$ (0, if the system is not a target node)
- $\text{ISDN CCS} = \text{PRI CCS} + \text{BRI CCS}$
- ISDN penetration factor:
- $p = \text{ISDN CCS} / \text{Total Voice Loop Traffic}$

- $\text{ISDN factor} = (1 - p)^2 + 4 \times (1 - p) \times p + 3 \times p^2$
- If Total Voice Loop Traffic > 3000 CCS, then
- Recommended number of call registers = $(0.04 \times \text{Total Voice Loop Traffic} + 0.18 \times \text{Number of ACD incoming trunks} + \text{Snacd} + \text{Tnacd} + 25) \times \text{ISDN factor}$
- If Total Voice Loop Traffic $\leq$ 3000 CCS, then
- Recommended number of call registers = $(\text{Number of system equipped ports} - \text{Number of ACD incoming trunks} - \text{Number of ACD agent sets}) \times 0.94 + \text{Number of ACD incoming trunks} + \text{Snacd} + \text{Tnacd} \times \text{ISDN factor}$

— Fixed address globals and OVL data space:

MS for fixed address globals + MS for OVL data space.

Overlay Cache (Omega systems only)

A Release 18 feature, Overlay Cache Memory, provides speedy access to overlays, but it also has the potential of significantly impacting memory usage. Average cache memory is considered to be five buffers, the maximum to be 32 buffers, at 57 Kbytes each. It is the largest impact on data store requirements for Release 18 and has the potential of using up to 1.8 Mbytes of memory out of a total of 6 Mbytes. However, the typical configuration of only five overlay buffers reduces incremental memory usage to 285 Kbytes. Systems may be configured with 2 to 32 overlay cache memory blocks of 19 kB each. Defining overlay cache buffers reduces the amount of memory available for data store.

Mass storage size

The Meridian 1 processor program and data are loaded from hard disk and/or floppies. The auxiliary processor operating system, programs, and data for such applications as Meridian MAX, Meridian Mail, Customer Controlled Routing, and Meridian 911 are loaded from tape. The capacities of these media along with brief descriptions of the layouts used for all processor types and applications are discussed in this section.

Meridian 1 processors

Meridian 1 processors include the Omega processors: (ST, STE, NT, XT, and options 21, 21E, 51, 61, and 71), and Thor processors: (options 51C, 61C, 81 and 81C). Thor systems have a very different architecture from the Omega systems. Thor and Omega are addressed in separate sections because their use of mass storage is fundamentally different.

Omega processors

On Omega systems, the hard disk and the floppies are laid out identically and perform the same function. The user can choose whether to upload/download from/to hard disk or floppy by selecting the appropriate options in the database configuration record (LD 17). [Table 32](#) illustrates the possible interactions between these two disk types and CPU.

Since release 20B, all systems have hard drives. Unattended sysload is supported only from hard disk, not from floppy, since more floppies are required to complete the load than there are floppy drives.

Table 32
Hard disk/floppy disk/CPU interactions

Interaction	Function performed
Floppies → CPU	Sysload program and data (if system has been configured for floppy sysload in LD 17)
CPU → floppies	Dump database (LD 43)
Floppies → hard disk	RESTORE database from floppies to hard disk (LD 43)
Hard disk → floppies	BACKUP database from hard disk to floppies (LD 43)
CPU → hard disk	Dump database (LD 43)
Hard disk → CPU	Sysload program and data (if system has been configured for hard disk sysload in LD 17)

Typically, the hard disk total area (up to 300,000 1-kB records) greatly exceeds that provided by the set of floppies (up to 4 floppies at up to 2850 1-kB records each). As a result, the hard disk has not been a constraining factor, whereas SL-1 program growth and data base expansion have required several upgrades to larger and larger floppies. [Table 33](#) shows the history of floppy drive upgrades.

Table 33
History of floppy drive upgrades

Introductory X11 release	Disk type	# of 1kB records per floppy	Floppy (MB)	Corresponding* hard disk (MB)
X11 release 9	5 1/4 inch	1140 records	1.1 MB	10 MB
X11 release 14	3 1/2 inch	1425 records	1.4 MB ("2MB")	20 MB
X11 release 18	3 1/2 inch	2850 records	2.8 MB ("4MB")	40 MB or higher
* Hard disk and floppy controls reside on the same card. A floppy upgrade implies a hard drive upgrade as well.				

Calculating floppy disk capacity for ST and option 21

The information in this section will help you decide whether your existing floppy disk configuration is satisfactory or a disk upgrade is required. Information on memory limitations for ST and option 21 systems is also presented.

Note: ST and option 21 systems cannot run X11 release 18 or later software. Therefore, this discussion is only applicable to 2 MB 3.5 inch floppy disks.

To determine if you have adequate disk space, you must determine available disk space when upgrading or expanding an existing system (the system provides the information during data dumps). The data presented is, at best, a rough approximation of the actual data on disk.

If the space required for data exceeds or approaches the available space, you must upgrade to 3.5 inch disks and/or a hard drive. It is wise to allow room for growth and uncertainties in the calculation, however it is suggested that you upgrade only when necessary.

Disk space available for data Use the following equation to determine available disk space:

Space available for data = Space available – Space required for software.

Space available on floppy disks = Storage space of disk type x Number of disks. See [Table 18](#).

Table 34
Storage space for floppy disk types

Disk type	5.25 inch	3.5 inch
Storage	1140 records	1425 records

For example, using two 3.5 inch disks, the storage space available is:

$$2 \times 1425 = 2850 \text{ records}$$

Disk space required for software (S/W) = Basic system + Optional packages + Packing factor.

Table 35
Disk space required for software in records

Software	ST
Basic system* (no optional packages)	1884.1
Optional packages	**
Packing factor***	80.0
*Basic system = Basic software load + Directory + Firmware + Sysload1 + Overlays + Intrinsic + Configuration + End of file **You can determine the number of records for options by adding the number of records per package for a specific machine type. ***Packing factor allows for the possibility of unusable space when disks are formatted to specific customer requirements. In the worst case, this is up to 80 records.	

Disk space required for data = Space currently occupied by data (printed during data dump) + Growth of data blocks* + Allowance for future system growth (at customer's discretion).

*At best, this is only an approximation and is dependent on configuration.

Table 36
Data block growth by upgrade to X11 R17

Upgrading to R17 from X11 release:	Use this percentage of Space currently occupied by data
R9 and R10	23%
R14	14%
R15	10%
Adding features to existing 15.56F (may require new data blocks or growth of existing blocks when activated)	0%
R16	5%

Optional package considerations for ST and option 21: Due to the large number of optional packages, you will not be able to run all optional packages on these systems. The number of optional packages you can equip depends on disk size. See [Figure 18](#).

Table 37
Disk space calculations—ST and option 21

Memory item	5.25 inch space (records)	3.5 inch space (records)
Space available on two disks	2,280	2,850
Subtract basic software load (including overlays, etc.)	~1,902	~1,902
Subtract packing factor*	~80	~80
Space available for data and optional program store	298	868
Subtract data store	~128	~128
Space available for optional program store	170	740
*Packing factor allows for the possibility of unusable space when disks are formatted to specific customer requirements. In the worst case, this is up to 80 records.		

Software on 5.25 inch disks There is insufficient space on the disk to accommodate all the memory contents, therefore not all of memory can be utilized.

All optional packages together require 423 kwords. There are only 85 kwords available on disk and 298.4 kwords in memory available for optional packages. Therefore, only 85 kwords are available for optional packages. More packages may be included if you are willing to sacrifice some of the space allocated for data store.

Software on 3.5 inch disks There is more than enough space on the disk to accommodate a completely full memory, therefore the number of optional packages installed is only limited by memory size.

All optional packages together require 423 kwords. While there are 370 kwords available on disk for optional packages, there are only 298.4 kwords in memory available for optional packages. (More packages may be included if you are willing to sacrifice some of the 64 kwords allocated for data store.)

All Non-option 81/61C/51C systems have floppy disks. Two drives are provisioned on each system, called the A and B drives. Hard disks are optional, but are normally considered essential for larger systems. If a hard disk is provisioned, it is laid out identically and can perform the same functions as the floppy disk, except that the media is not removable. Once the data has been placed on the hard disk (via the EDD function of LD43) the user can choose whether to sysload from the hard disk or floppy by selecting the appropriate options in the Meridian 1 data base configuration record (LD17).

Over the years, several vintages of floppy disk drives and media have been supported. [Table 38](#) shows, for each type of drive, the physical dimensions, the size in records, the X11 release which introduced the drive, and the corresponding hard disk size at that release.

Table 38
Floppy disk drives

Physical dimensions	KByte records	Introductory X11 release	Floppy MBytes	Hard disk MBytes
5.25"	1140	14	1.1Mb	10Mb
3.5"	1425	17	1.4Mb	20Mb
3.5"	2850	18	2.8Mb	40Mb

Note: This applies to options 51/61/71 only. On options 51C/61C/81/81C, "4Mb" (2850 1 Kb record) 3.5" floppies are used. The hard disk is partitioned into a 30Mb unprotected partition and a 60Mb protected partition. The total hard disk size can range from 120Mb to 300Mb, depending on when it was purchased. For more information, see "Mass Store on option 51C/61C/81/81C systems (NT6D66, NT9D19, and NT5D10 CP cards)" on page 128.

The hard disk total area (up to 40,000 1K byte records) greatly exceeds that provided by the set of floppies (2 or more floppies at 2850 1K byte records each). As a result, the hard disk size is not a constraining factor on system capacities.

Disk Layout The layout of data on disks is the same, regardless of drive type. There can be multiple A disks (though there is usually only one) and one B disk. The A disks contain the package directory, the Meridian 1 program, most overlays, and an End of File (EOF) record. The B disk contains the Meridian 1 database, the hardware configuration record, firmware, the rest of the overlays, if any, and an EOF record.

Omega floppy drives (all types) have slots for two disks, disk A and disk B.

There can be multiple A disks and one B disk. The A disk contains the package directory, the Meridian 1 program, most overlays, and an End of File (EOF) record. The B disk contains the Meridian 1 database, the hardware configuration record, firmware, the rest of the overlays (if any), and an EOF record.

The hard disk is laid out identically to the floppies, with the disk B contents following that of disk A. Overlays are stored in ascending order by overlay number.

Sysload design requires that the entire database reside on one disk, disk B. SL-1 software may overflow onto a second disk. PSDL must reside on one disk—either the first A disk or the B disk.

The layout of data on disks is the same, regardless of drive type. There can be multiple A disks (though there is usually only one) and one B disk. The A disks contain the package directory, the Meridian 1 program, most overlays, and an End of File (EOF) record. The B disk contains the Meridian 1 database, the hardware configuration record, firmware, the rest of the overlays, if any, and an EOF record.

Figure 9
Disk layouts and contents

Disk A	Disk B
Sysload & Directory ~ (10–20 records)	Configuration Record 1 record
Firmware ~ (2–10 records)	Rest of SL-1 Overlays ~ (200–1,000 records)
SL-1 Overlays ~ (200 up to 1,800 records)	
Overflow to 2nd A disk, if necessary (releases before 18 only)	PSDL ~ (900–2,100 records) (Peripheral Software Download)
SL-1 Resident SW ~ (800 up to 3,600 records)	
↓	User Database ~ (300–1,500 records)
Overflow to 2nd A disk, if necessary (for release 18 and beyond).	
EOF 1 record	EOF 1 record

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Disk space computations

The three variable components of disk space are program store, office data, and Peripheral Software download (PSDL). Methods used to determine their mass storage requirements are described below.

Program store The SL-1 program occupies space on the disks according to the following formula:

$$\text{number of disk records} = \text{sw} \times \text{c} \times \text{d}$$

where

- sw = overlay size + resident software size + firmware size in SL-1
kwords
- c = a disk storage overhead factor of 1.03
- d = conversion factor from words to bytes, which varies by machine
type, as shown in [Table 39](#)

Table 39
Number of Bytes per SL-1 word

Option 21, ST	Options 21E, 51, 61, 71, XT and NT
2	3

In the sw term, overlay and resident SL-1 program size are feature package dependent, as discussed in [“Memory size” on page 89](#). [Table 40](#) illustrate for supported releases Program Store record counts assuming all packages equipped.

Table 40
Program store disk capacity requirements (1 kB records)

Release	Program	Store	=	Resident sw/fw	+	Overlay sw	
	ST	Option 21		NT/XT	Option 51	Option 61/71	Option 21E
14	1770			1880			
17	2390	2390		2555	2555	2555	
18				2975	2975	2975	2975
19				3479	3479	3479	3479
20A					5314	5314	3100*
20B					5406	5406	5406
21					5876	5876	5876
*Code was compressed to allow sysload from two floppies. At release 20A, not all 21E had hard disk drives.							

The Meridian 1 program occupies space on the A disks according to the following formula:

$$\# \text{ disk records} = SW * c * d$$

where SW = Overlay size + Resident size + Firmware size (in K words). These quantities are feature package dependent, as shown in the Memory section of this document.

c = a disk storage overhead expansion factor, currently 1.03

d = the conversion factor from words to bytes (see [Table 41](#))

Table 41
Word to byte conversion factors

System option	Conversion factor
ST, STA, 21, 21A	3
NT, XT, 51, 61, 71	2

Office data Since the sysload program requires that the entire database and PSDL reside on a single floppy (Disk B), floppy size is a constraint when creating databases. [Table 42](#) shows typical and maximum database sizes for the different machine types.

Table 42
Database sizes (1 kB records)

Machine type	Typical large database	Largest known database
ST/option 21/21A/21E	200	375
RT/NT/option 51/61	500	625
XT/option 71/81	1000	1725

On an existing system, database size can be measured by performing an EDD in LD 17. After completing the EDD, the system will print the database size in number of records to the TTY port.

There are two components to consider in estimating the database size for a new system—the size of the protected data store and the cell register space required. Use the procedure described in [“Data store” on page 105](#) to estimate the protected data store size. Estimate call register space as follows:

Call Register Call register space (in 1kB records) = Number of call registers x Number of words per call register x Number of bytes per word + 1,024 bytes/kB.

Table 43
Typically maximum number of call registers by machine type

Machine Type	Number of call registers (Typical)	Number of call registers (Maximum)
Option 11E	120	200
Option 21E	450	750
Option 51/61	600	1000
Option 71	1200	2000

Table 44
Number of words per call register by release

Release	Words per call register data block
19	103
20A	158
20B	161
21	169

Now that you have computed the protected data space and call register space requirements (in 1kB records), compute the total data space requirement as follows:

Data space required = protected data space + unprotected data space + (assume the same space requirement as for protected data space) + call register space.

Mass Store on option 51C/61C/81/81C systems (NT6D66, NT9D19, and NT5D10 CP cards)**Software installation and SYSLOAD**

On the Thor machines, the SL-1 program is loaded to hard disk via an external medium and then SYSLOAD is performed from the hard disk. (Due to the need to accomodate a much larger and growing SL-1 program, this is a departure from the Omega machines, on which the floppies and the hard disk were interchangeable as means of uploading the SL-1 program and SYSLOAD could be performed from either.) At present the software uploading medium is either a stack of 8-16 4MB floppy disks, on systems purchased prior to Release 23, or a CD-ROM, on systems purchased from Release 23 on. The SL-1 customer database is loaded to the hard disk on a separate floppy, which can be rewritten via a “backup” operation or reread to hard disk via a “restore” operation (LD 43).

The hard disk total capacity is a function of whatever is currently available from the manufacturers. At present, the disks being shipped with the Meridian 1 are 2GB. Whatever the total capacity, however, the actual storage capacity available to the Meridian 1 is determined by the disk partitioning into the protected and unprotected area. Since Release 21 this has been set at 30MB for unprotected and 60MB for protected.

Pre-Release 23 : IOP/CMDU

Prior to Release 23, the software uploading medium was a 4MB disk drive. The SL-1 program was read in from a stack of 4MB floppies. (A stack of 8 in Release 18 and a stack of 16 by Release 23.) This is being replaced in Release 23 by the introduction of the Input/Output Disk Unit with CD-ROM (IODU/C) card, which introduces a CD-ROM - floppy drive combination discussed in the next section. IODU/C preserves the architectural characteristics of the IOP/CMDU recognized by the rest of the system - the CP-IOP interface, and the Ethernet and SCSI capabilities of the IOP family.

Release 23 : IODU/C

By means of the IODU/C feature, Release 23 introduces software delivery by CD-ROM to Meridian 1 systems. IODU/C incorporates a Keycode based S/W installation and feature expansion methodology. Highlights of IODU/C include:

- Software delivery via CD plus single install floppy. This replaces the (large) stack of floppies required to install software in the past.
- Replacement of single 4MB floppy drive with a 2MB drive.

The IODU/C hardware replaces the old IOP/CMDU pack in the exact same three slots; ie., the old and the new are incompatible. In Release 23 IODU/C will be shipped with all new systems and all hardware upgrades. The IOP/CMDU is still supported on upgrades to Release 23 that involve software only.

The following table provides the expected maximum floppy disk space required (before compression) by SL-1 databases for the supported option 51C/61C/81/81C machine types. These are conservative but realistic estimates; that is, not all sites with the given machine type will have databases as large as shown.

Table 45
Floppy Disk Space Requirements Projection for SL-1 Customer Data (MB)

	Rls 23
51C with NT6D66 CP card	0.534
61C with NT6D66 CP card	0.816
81/81C with NT6D66 CP card	2.087
51C with NT9D19 CP card	0.746
61C with NT9D19 CP card	1.169
81/81C with NT9D19 CP card	3.076
51C with NT5D10 CP card	0.955
61C with NT5D10 CP card	1.519
81/81C with NT5D10 CP card	4.055

Hard disk layout The hard disk has a total capacity of at least 120 MB. See [Table 48](#) for a description of disk capacities by X11 release. In addition to program and data storage, there is also a maintenance report database which provides logging capabilities. The hard disk is divided into two partitions—protected and unprotected. The protected partition uses 60MB (as of Release 21) and the unprotected partition uses 30 MB.

Table 46
Option 51C/61C/81/81C hard disk partitioning—Protected

Protected Partition (MB)	R20B	R21	R22	R23
SL_1 resident + overlay code	13.89	14.74	19.22	20.37
PSDL	2.01	2.07	7.16	8.19
OS code + data + tools	0.63	0.75	0.88	1.01
Report database	0.80	0.88	0.97	1.04
Language files	5.00	5.00	5.00	5.00
Total	22.33	23.44	33.23	35.61
Partition size	30	60	60	60

Table 47
Option 51C/61C/81/81C hard disk partitioning—Unprotected

Unprotected Partition (MB)	R20B	R21	R22	R23
SL_1 database (option 81 Pdata + backup) (NT6D66 CP card is shown prior to Release 23, NT5D10 CP card is shown for Release 23 as it is the biggest data user)	2.87	3.37	3.60	7.89
Report log file	0.50	0.50	2.55	2.55
HW infrastructure DB + backup	0.21	0.22	0.22	0.22
Patches	1.00	2.00	3.00	3.00
Microcell Mobility Data			10.00	10.00
Total	4.58	6.09	19.37	23.661
Partition size	30	30	30	30
Hard Disk Capacity (MB)	245	300	300	2000

Table 48
History of hard disk sizes

X11 release	Manufactured capacity		Space for Omega systems		Thor partition size
	Floppy size	1 kB records (floppy)	Hard disk MB	MB	Protected/ Unprotected MB
9	5.25"	1140	10	9.6	N/A
15*	3.25	1425	20	12	N/A
17	3.25	2850	40	24	N/A
18	3.25	2850	80	24	N/A
18	3.25	2850	120	24	30/30
19	3.25	2850	245	24	30/30
20	3.25	2850	300	24	30/30
21	3.25	2850	300	24	60/30
22	3.25	2850	300	N/A	60/30
23	3.25	1425 **	2000	N/A	60/30
*Hardware breakpoint for floppy and hard disk. Entirely new MSU.					
**In Release 23, new systems (IODU/C delivery) have 2MB floppies.					

On the option 81/61C/51C processor the hard disk and floppies are not interchangeable. The floppies perform a one-time upload of the Meridian 1 program and data; then sysloads are performed from the hard disk. In addition to storing floppy contents, the hard disk is used for maintenance reports and other logging capabilities. As on the OMEGA processor, the database is confined to a single floppy, so that there is a potential constraint imposed by floppy size. The hard disk, at a minimum of 120 Mbytes of storage, is not a constraining factor at this time.

Floppy disk layout The number of floppies required to load the program (including the final data disk) has grown since the introduction of the Thor system, as follows.

Table 49
Number of program floppy disks (4MB)

Release	Number of floppy disks
18	7
19	7
20A, 20B	8
21	9
22	11
23 *	16

Release 23 software is shipped using the old CMDU / IOP floppy disk delivery system if the site is a software-only upgrade. Otherwise, software is shipped via CD-ROM in the new IODU/C delivery system.

The database floppy has 2850 1 kB records, of which 5 are reserved for overhead. The remaining 2845 are available for database and patches.

Table 50
Floppy disk layout: 2850 records available

Use	Approximate number of records occupied
SL-1 database overhead	3
Hardware infrastructure database	2
User database (largest presently known)	1725
Patches	use remaining space

Auxiliary processors

Currently, auxiliary processors include Meridian MAX, Meridian Mail, Customer Controlled Routing, and Meridian 911. These all incorporate a 155 MB tape drive and a hard disk (either 172 MB, 240 MB or 520 MB). The processor's UNIX® Operating System is loaded to hard disk from one tape, and the application program and data from another. In addition to the operating system and application program and data, the hard disk also accommodates caching areas and third-party applications.

[Table 51](#) lists the various auxiliary processors and shows the sizes of the mass storage media for each. To see the available space on these media, see [“Worksheets” on page 231](#).

Table 51
Mass storage media for the auxiliary processors

Product	System tape	Applications tape	Hard disk	Comments/projections
Meridian Link Module	155 MB	155 MB	172 MB	These products all use the same system software.
Customer Controlled Routing	155 MB	155 MB	172 MB	
911 Services	155 MB	155 MB	172 MB	
ACD Reporting System MAX4 / MiniMAX	155 MB	155 MB	172 MB	Uses a subset of the available system software.
ACD Reporting System MAX5	155 MB	155 MB	520 MB	
Interactive Voice Response	155 MB	155 MB	240 MB	

Refer to the following documents for information regarding the auxiliary processors:

— *Meridian MAX Installation* (553-4001-111)

Meridian Link/Customer Controlled Routing:

— *Meridian Link installation* (553-3201-210)